PB83-209684

Implementation of Innovative Dredging Techniques in the Chesapeake Bay Region

MITRE Corp., McLean, VA

Prepared for

Environmental Protection Agency, Annapolis, MD

May 83

U.S. Department of Commerce
National Technical Information Service
NTIS

PB83-209684

EPA-600/3-83-039
May 1983

IMPLEMENTATION OF INNOVATIVE DREDGING TECHNIQUES IN THE CHESAPEAKE BAY REGION

by

Don Aurand and Alexandra Mamantov
The MITRE Corporation
Mitrek Division
McLean, Virginia 22102

Grant CR 807987-01-0

EPA Project Officer
Mark Alderson

U.S. Environmental Protection Agency
Chesapeake Bay Program
2083 West Street
Annapolis, Maryland 21401

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA 22161

BEGIN FIRST LINE OF TEXT HERE
CENTER OF PAGE
TOP OF IMAGE AREA
DROPPED HEAD: BEGIN SECTIONS HERE
6 1/2"
9 1/2"
BEGIN LAST LINE OF TEXT
3/8"
PAGE NUMBER
TYPING GUIDE SHEET

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/3-83-039

2.

3. RECIPIENT'S ACCESSION NO. PB83 209684

4. TITLE AND SUBTITLE
Implementation of Innovative Dredging Techniques in the Chesapeake Bay Region

5. REPORT DATE May 1983

6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)
Don Aurand and Alexander Mamantov ra

8. PERFORMING ORGANIZATION REPORT NO.

9. PERFORMING ORGANIZATION NAME AND ADDRESS
The MITRE Corporation
Metrek Division
1820 Dolley Madison Boulevard
McLean, VA 22102

10. PROGRAM ELEMENT NO.

11. CONTRACT/GRANT NO. CR 807987010

12. SPONSORING AGENCY NAME AND ADDRESS
U.S. EPA
Chesapeake Bay Program
2083 West Street
Annapolis, Maryland 21401

13. TYPE OF REPORT AND PERIOD COVERED Project Report

14. SPONSORING AGENCY CODE EPA/600/05

15. SUPPLEMENTARY NOTES

16. ABSTRACT

The environmental effects of dredging and dredged material disposal have been an issue in the Chesapeake Bay Region for some time. Recent concerns over dredging and disposal in the Baltimore Harbor area have been particularly strong, and have resulted in significant project delays. Possible solutions would be to improve either the technologies or the management processes associated with dredging. This report reviews eleven years of dredging records for federal projects, six years of dredging records for private projects, current management programs, and the scientific literature in order to define current programs and their impacts. Potential technological improvements are also described. This information was then used to prepare a series of recommendations for improving dredging practices in the Chesapeake Bay.

It would appear that current operations do not have a major impact on the ecology of the bay, but that some attention should be given to future programs in order to ensure that the situation does not deteriorate. Specific suggestions with respect to possible improvements are: implementation of study programs to more clearly define the chemical nature of the sediments, better long-range planning with respect to disposal options, comprehensive monitoring programs to clarify long-term impacts, use of incentive payments t to encourage innovative technologies, replacement of seasonal dredging restrictions by turbidity standards, possible federal ownership of a small, pneumatic dredge for use in highly polluted areas, and repeal or modification of those portions of the Jones Act affecting importation of dredging equipment.

17.

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

18. DISTRIBUTION STATEMENT
Unrestricted distribution

19. SECURITY CLASS *(This Report)* Unclassified

20. SECURITY CLASS *(This page)* Unclassified

21. NO. OF PAGES 202

22. PRICE

EPA Form 2220-1 (9-73)

NOTICE

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

ABSTRACT

The environmental effects of dredging and dredged material disposal have been an issue in the Chesapeake Bay region for some time. Recent concerns over dredging and disposal in the Baltimore Harbor area have been particularly strong, and have resulted in significant project delays. Possible solutions would be to improve either the technologies or the management processes associated with dredging. This report reviews eleven years of dredging records for federal projects, six years of dredging records for private projects, current management programs, and the scientific literature in order to define current programs and their impacts. Potential technological improvements are also described. This information was then used to prepare a series of recommendations for improving dredging practices in the Chesapeake Bay.

It would appear that current operations do not have a major impact on the ecology of the bay, but that some attention should be given to future programs in order to ensure that the situation does not deteriorate. Specific suggestions with respect to possible improvements are: implementation of study programs to more clearly define the chemical nature of the sediments, better long-range planning with respect to disposal options, comprehensive monitoring programs to clarify long-term impacts, use of incentive payments to encourage innovative technologies, replacement of seasonal dredging restrictions by turbidity standards, possible federal ownership of a small, pneumatic dredge for use in highly polluted areas, and repeal or modification of those portions of the Jones Act affecting importation of dredging equipment.

ACKNOWLEDGEMENTS

Most of the data presented in this report were obtained from the Corps of Engineers, Baltimore and Norfolk Districts. The assistance of the following staff members has been greatly appreciated. In the Baltimore District: Thomas Filip, Jeffrey McKee, and Dave Kingston and in Norfolk: Gene Whitehurst, Cecil Toxey, Mark Harrell, and Bruce Williams. William Holland from the Great Lakes Dredge and Dock Company, Russel Thorne from Norfolk Dredging Company, and William Schwarz from McLean Construction Company are also gratefully acknowledged for openly discussing current dredging issues. Mr. Ernest Krajeski at MITRE has assisted in reviewing and editing this report. His suggestions were most helpful and his help greatly appreciated. We would also like to thank the other MITRE reviewers, Dr. Wade Smith, Dr. Anthony Bisselle and Mr. Will Jacobsen, and the various agency reviewers for their careful review and valuable suggestions. Special thanks to Mrs. Dee Fitzgerald, Mrs. Zelda Gray, Ms. Susie Armstrong, and Ms. Jamesetta Simpson for helping to prepare the manuscript, and to Ms. Elaine Mullen for her excellent illustrations. Final typing was done by Mrs. Debra Hansbrough.

TABLE OF CONTENTS

Page

LIST OF ILLUSTRATIONS ix

LIST OF TABLES xi

1.0 INTRODUCTION 1

1.1 Objectives of the Study 2
1.2 Project Approach 3
1.3 Background Information 3

2.0 COMPILATION AND REVIEW OF DREDGING RECORDS FOR THE CHESAPEAKE BAY 7

2.1 Location and Size of Dredging Projects 10

  2.1.1 Federal Projects 10
  2.1.2 Non-Federal Projects 20

2.2 Utilization of Dredging Equipment 23

  2.2.1 Federal Projects 23
  2.2.2 Non-Federal Projects 23

2.3 Cost of Dredging 23

  2.3.1 Federal Projects 23
  2.3.2 Non-Federal Projects 26

2.4 Disposal Methods 28

  2.4.1 Federal Projects 28
  2.4.2 Non-Federal Projects 32

3.0 REGULATORY PROGRAMS AFFECTING DREDGING IN THE CHESAPEAKE BAY 35

3.1 Federal Legislation and Regulations 35

  3.1.1 Section 401 of the Clean Water Act 35
  3.1.2 Section 404 of the Clean Water Act 36
  3.1.3 River and Harbor Act of 1899 37
  3.1.4 Section 103 of the Marine Protection, Research and Sanctuaries Act 38

TABLE OF CONTENTS (Continued)

Page

3.1.5 Other Federal Legislation 38
3.1.6 Federal Implementing Regulations 41

3.2 State of Maryland Legislation and Regulations 42
3.3 Commonwealth of Virginia Legislation and Regulations 42
3.4 Permit Processing Procedures 43

4.0 IMPACT OF CURRENT DREDGING PRACTICES 45

4.1 Perceived Environmental Issues 45
4.2 Probable or Documented Environmental Impacts in the Aquatic Environment 46

4.2.1 Physical Impacts 46
4.2.2 Chemical Impacts 48
4.2.3 Biological Impacts 50
4.2.4 Public Health Impacts 54

4.3 Possible Impacts of Terrestrial or Confined Disposal of Dredged Material 54
4.4 Regulatory Controls 55
4.5 Economic Costs 55

5.0 IDENTIFICATION AND DESCRIPTION OF AVAILABLE TECHNOLOGIES 57

5.1 Mechanical Dredges 58

5.1.1 Clamshell or Grab Bucket Dredges 58
5.1.2 Dragline Dredges 62
5.1.3 Dipper Dredges 63
5.1.4 Bucket Ladder Dredges 63
5.1.5 Backhoes 66

5.2 Hydraulic Dredges 66

5.2.1 Plain Suction Pipeline Dredges 67
5.2.2 Cutterhead Suction Dredges 67
5.2.3 Dustpan Dredge 70
5.2.4 Trailing Section Hopper Dredges 75
5.2.5 Sidecaster Dredges 80
5.2.6 Bucket Wheel Dredges 80
5.2.7 Mudmaster 82
5.2.8 Delta Dredge 82

TABLE OF CONTENTS (Continued)

Page

5.2.9 MUD CAT 84
5.2.10 Waterless Dredge 86

5.3 Pneumatic Dredges 86

5.3.1 The Airlift 87
5.3.2 The Oozer 87
5.3.3 The AMTEC System 90

5.4 Ancillary Equipment 93

5.4.1 Silt Curtains 93
5.4.2 Positioning Equipment 93

6.0 PROCEDURES FOR EVALUATION OF ALTERNATIVE TECHNOLOGIES AND MANAGEMENT PLANS 95

6.1 Economics 97
6.2 Availability 97
6.3 Environmental Impacts 98
6.4 Compatability with Existing Regulations 98

7.0 EVALUATION OF POTENTIAL MODIFICATIONS IN TECHNOLOGY OR MANAGEMENT PRACTICES 99

7.1 Screening of Available Options 99

7.1.1 Use of Improved Dredging Equipment on Large Projects 100
7.1.2 Increased Use of Silt Curtains 100
7.1.3 Use of Improved Navigation or Positioning Equipment 100
7.1.4 Use of Pneumatic Dredges for Polluted Material 101
7.1.5 Increased Use of Hydraulic or Pneumatic Dredges on Small, Private Projects 102
7.1.6 Establishment of Turbidity Standards to Replace Seasonal Dredging Moratoriums 103
7.1.7 Increased Chemical and Bioassay Testing of Sediments 104
7.1.8 Development of Comprehensive Monitoring Studies to Clarify Long-Term Impacts 105
7.1.9 Use of Advanced Treatment Methods in Confined Disposal Areas 106
7.1.10 Establishment of Additional Confined Disposal Areas 106

TABLE OF CONTENTS (Concluded)

Page

7.1.11 Further Improvement to the Permit Review Process 107
7.1.12 Revisions to the Effluent Standards for Upland Disposal Areas 107
7.1.13 Repeal or Modification of the Jones Act 108

7.2 Program Recommendations 108

APPENDIX A DREDGING STATISTICS 111

APPENDIX B EQUIPMENT OWNED BY MAJOR DREDGING COMPANIES WORKING IN THE CHESAPEAKE BAY 169

APPENDIX C BIBLIOGRAPHY 173

LIST OF ILLUSTRATIONS

FIGURE NUMBER		Page
2-1	Location of Volumes Associated with Dredging in Federally Maintained Channels in the Northern Portion of the Chesapeake Bay Region, Fiscal Year 1970 through Fiscal Year 1980	8
2-2	Location of Volumes Associated with Dredging in Federally Maintained Channels in the Southern Portion of the Chesapeake Bay Region, Fiscal Year 1970 through Fiscal Year 1980	9
2-3	Volume of Material Dredged Annually from Federal Projects in the Baltimore and Norfolk Districts, Fiscal Years 1970 through 1980	16
2-4	Volume of Material Dredged Annually from Non-Federal Projects in the Baltimore and Norfolk Districts, Fiscal Years 1975 through 1980	21
2-5	Annual Average Cost of Dredging on Federal Projects in the Baltimore and Norfolk Districts, Fiscal Years 1970 through 1980	27
2-6	Disposal Options for Material Dredged from Federal Projects in the Baltimore and Norfolk Districts, Fiscal Years 1970 through 1980	31
5-1	Clamshell Dredge	60
5-2	Dipper Dredge	64
5-3	Bucket Ladder Dredge	64
5-4	Cutterhead Suction Dredge	69
5-5	Dustpan Dredge	74
5-6	Trailing Suction Hopper Dredge	76
5-7	Ellicott "Wheel Dragon" Excavator	81
5-8	Delta Dredge	83

LIST OF ILLUSTRATIONS (Concluded)

FIGURE NUMBER		Page
5-9	MUD CAT	85
5-10	Oozer Pump System	89
5-11	AMTEC Pump System	91
6-1	Screening Criteria Used for Choosing New Dredging Techniques	96

LIST OF TABLES

TABLE NUMBER		Page
2-1	Federal Dredging Projects in the Baltimore District, Fiscal Years 1970 through 1980	12
2-2	Federal Dredging Projects in the Norfolk District, Fiscal Years 1970 through 1980	13
2-3	Frequency Distribution of the Volume of Material Dredged Annually from Federal Projects in the Baltimore and Norfolk Districts, Fiscal Years 1970 through 1980	15
2-4	A Summary of Volume and Cost Data for Dredging in the Baltimore District, Fiscal Years 1970 through 1980	17
2-5	A Summary of Volume and Cost Data for Dredging in the Norfolk District, Fiscal Years 1970 through 1980	18
2-6	Frequency Distribution of the Volume of Material Dredged Per Permit in Non-Federal Projects in the Baltimore and Norfolk Districts, Fiscal Years 1975 through 1980	22
2-7	Volume of Material Dredged, by Type of Equipment, on Non-Federal Projects in the Chesapeake Bay Region, Fiscal Years 1975 through 1980	24
2-8	Frequency Distribution of the Volumes of Material Dredged on Non-Federal Projects, by Type of Dredging Equipment, in the Baltimore and Norfolk Districts, Fiscal Years 1975 through 1980	25
2-9	Examples of Large Private Dredging Projects Performed by a Private Contractor in the Last Five Years	29
2-10	Disposal Options for Material Dredged from Federal Projects in the Baltimore and Norfolk Districts, Fiscal Years 1970 through 1980	30

LIST OF TABLES (Continued)

TABLE NUMBER		Page
5-1	General Characteristics of Mechanical Dredges	59
5-2	General Characteristics of Hydraulic Dredges	68
5-3	Ellicott Corporation Cutterhead Suction Dredges	71
5-4	C.F. Bean Corporation Cutterhead Suction Dredges	72
5-5	American Marine and Machinery Co., Inc. Cutterhead Suction Dredges	73
5-6	General Characteristics of Pneumatic Dredges	86
A-1	Dredging Statistics for Federal Projects in the Chesapeake Bay: Baltimore District; Fiscal Year 1970	112
A-2	Dredging Statistics for Federal Projects in the Chesapeake Bay: Baltimore District; Fiscal Year 1971	113
A-3	Dredging Statistics for Federal Projects in the Chesapeake Bay: Baltimore District; Fiscal Year 1972	114
A-4	Dredging Statistics for Federal Projects in the Chesapeake Bay: Baltimore District; Fiscal Year 1973	115
A-5	Dredging Statistics for Federal Projects in the Chesapeake Bay: Baltimore District; Fiscal Year 1974	116
A-6	Dredging Statistics for Federal Projects in the Chesapeake Bay: Baltimore District; Fiscal Year 1975	117
A-7	Dredging Statistics for Federal Projects in the Chesapeake Bay: Baltimore District; Fiscal Year 1976	118

LIST OF TABLES (Continued)

TABLE NUMBER		Page
A-8	Dredging Statistics for Federal Projects in the Chesapeake Bay: Baltimore District; Fiscal Year 1977	119
A-9	Dredging Statistics for Federal Projects in the Chesapeake Bay: Baltimore District; Fiscal Year 1978	120
A-10	Dredging Statistics for Federal Projects in the Chesapeake Bay: Baltimore District; Fiscal Year 1979	121
A-11	Dredging Statistics for Federal Projects in the Chesapeake Bay: Baltimore District; Fiscal Year 1980	122
A-12	Dredging Statistics for Federal Projects in the Chesapeake Bay: Norfolk District; Fiscal Year 1970	123
A-13	Dredging Statistics for Federal Projects in the Chesapeake Bay: Norfolk District; Fiscal Year 1971	124
A-14	Dredging Statistics for Federal Projects in the Chesapeake Bay: Norfolk District; Fiscal Year 1972	125
A-15	Dredging Statistics for Federal Projects in the Chesapeake Bay: Norfolk District; Fiscal Year 1973	126
A-16	Dredging Statistics for Federal Projects in the Chesapeake Bay: Norfolk District; Fiscal Year 1974	127
A-17	Dredging Statistics for Federal Projects in the Chesapeake Bay: Norfolk District; Fiscal Year 1975	128
A-18	Dredging Statistics for Federal Projects in the Chesapeake Bay: Norfolk District; Fiscal Year 1976	129

LIST OF TABLES (Continued)

TABLE NUMBER		Page
A-19	Dredging Statistics for Federal Projects in the Chesapeake Bay: Norfolk District; Fiscal Year 1977	130
A-20	Dredging Statistics for Federal Projects in the Chesapeake Bay: Norfolk District; Fiscal Year 1978	131
A-21	Dredging Statistics for Federal Projects in the Chesapeake Bay: Norfolk District; Fiscal Year 1979	132
A-22	Dredging Statistics for Federal Projects in the Chesapeake Bay: Norfolk District; Fiscal Year 1980	133
A-23	Dredging Statistics for Private Contracts in the Chesapeake Bay: Norfolk District; Fiscal Year 1975	134
A-24	Dredging Statistics for Private Contracts in the Chesapeake Bay: Norfolk District; Fiscal Year 1976	136
A-25	Dredging Statistics for Private Contracts in the Chesapeake Bay: Norfolk District; Fiscal Year 1977	138
A-26	Dredging Statistics for Private Contracts in the Chesapeake Bay: Norfolk District; Fiscal Year 1978	141
A-27	Dredging Statistics for Private Contracts in the Chesapeake Bay: Norfolk District; Fiscal Year 1979	143
A-28	Dredging Statistics for Private Contracts in the Chesapeake Bay: Norfolk District; Fiscal Year 1980	145
A-29	Dredging Statistics for Private Contracts in the Chesapeake Bay: Baltimore District; Fiscal Year 1975	147

LIST OF TABLES (Concluded)

TABLE NUMBER		Page
A-30	Dredging Statistics for Private Contracts in the Chesapeake Bay: Baltimore District; Fiscal Year 1976	151
A-31	Dredging Statistics for Private Contracts in the Chesapeake Bay: Baltimore District; Fiscal Year 1977	155
A-32	Dredging Statistics for Private Contracts in the Chesapeake Bay: Baltimore District; Fiscal Year 1978	158
A-33	Dredging Statistics for Private Contracts in the Chesapeake Bay: Baltimore District; Fiscal Year 1979	162
A-34	Dredging Statistics for Private Contracts in the Chesapeake Bay: Baltimore District; Fiscal Year 1980	166
B-1	Major Companies Performing Federal Dredging Work in the Chesapeake Bay and Available Equipment	170

1.0 INTRODUCTION

This report was prepared under contract to the Chesapeake Bay Program of the U.S. Environmental Protection Agency. After completion of the draft report in August 1981, it was sent out for peer review under standard procedures used for Chesapeake Bay Program reports. Comments were received from the following agencies:

- State of Maryland
    - Office of Environmental Programs, Department of Health and Mental Hygiene
    - Tidewater Administration, Department of Natural Resources

- Commonwealth of Virginia
    - State Water Control Board

- U.S. Army Corps of Engineers
    - Norfolk District Office

- U.S. Environmental Protection Agency
    - Office of Federal Activities
    - Chesapeake Bay Program

Where appropriate, the suggestions of these reviewers are incorporated into the report without comment. In a few cases, however, suggestions made by the reviewer represent reinterpretations of data or opinions by the reviewers based on regulatory positions or philosophies. In such cases, if we still do not agree with the reviewer we have inserted a summary of the comment and our reasons for disagreeing. This will allow the reader to form his own opinions concerning the issues.

The final comments on the report were received in February 1982. In the fall of 1981, the federal government began an extensive reevaluation of the role of federal agencies in a wide range of environmental issues, including dredging. This review, ordered by President Reagan, focused on several specific pieces of legislation. Among them was Section 404 of the Clean Water Act, which regulates the discharge of dredged or fill material into the waters of the United States. In addition, as a result of a suit brought in Federal Court by the National Wildlife Federation, EPA was directed on 2 July 1980 by the U.S. Court of Appeals of the District of Columbia (Docket No. 78-2167) to promulgate revised Ocean Dumping Regulations issued under Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (PL92-532). At this time (February 1982) it appears that the new ocean dumping criteria will require a more complete review of the costs of alternatives which might be selected if ocean dumping is rejected. However, no changes have been officially made in either of the programs authorized by these pieces of legislation, so it is not possible to address the potential impacts of such changes on the Chesapeake Bay. Section 3.0 of this report discusses the existing regulations; however, the reader should be aware that it is quite likely that changes will occur sometime in 1982, either in the regulations, the enabling legislation, or both.

Finally, the opinions in this report are solely those of the authors, and do not reflect official opinions or policies of the U.S. Environmental Protection Agency, or of any of the reviewers. Suggested actions listed in Section 7.2 are intended only to stimulate discussions among the responsible agencies on issues that the authors perceive to be critical to the future well-being of the bay; they are not necessarily the only, or perhaps even the best in all respects, alternatives for implementation at this time.

1.1 Objectives of the Study

This study is a review and evaluation of dredging equipment and practices currently in use in the Chesapeake Bay, with the goal of recommending changes which would have either an economic or ecological benefit. Specifically, the report addresses the following questions:

- How much material is dredged in the Chesapeake Bay, in what locations, and with what type of equipment?
- What are the economic and ecological impacts of the practices?
- What are the latest advances in dredging technology which could be implemented in the Chesapeake Bay?
- What is the role of government regulation in dredging in the Chesapeake Bay?
- Are there technological or managerial options available which would significantly improve present practices?

This study specifically does not address technologies associated with disposal options, only those involved in actual dredging. Issues related to disposal are considered in terms of their general implications.

1.2 Project Approach

Data collection procedures are detailed in Section 2.0. However, in summary, dredging statistics were obtained from the Baltimore and Norfolk District Offices of the U.S. Army Corps of Engineers (COE). Information on cost and equipment was obtained from the COE, regional dredging companies, and the open literature. Information on impacts was obtained from state and federal officials and the open literature. After the data were collected, the major issues related to current dredging practices were identified, and new technologies were reviewed to see if they could resolve any of these issues. Finally, managerial options were also reviewed and potential revisions suggested.

1.3 Background Information

The ports of the Chesapeake Bay region have been a center for commerce, fishing, and recreation since their settlement. As appears to be the case in many areas of the east coast, a combination of increased vessel drafts and increased sedimentation due to agricultural development and urban construction have created a situation where dredging is essential to maintain the viability of these ports. Most, but not all, dredging is associated with the maintenance of the port facilities at Baltimore and Norfolk. These two areas are among the ten largest ports in the United States, and make a very significant contribution to the regional economy.

While a wide range of cargoes moves through both of these ports, their role in the transshipment of domestic coal for export appears to be the most significant factor in their future development. Hampton Roads is currently the leading U.S. coal export port, handling approximately 75 percent of the total volume, while Baltimore is the second leading port, handling an additional 20 percent of the total (Office of Technology Assessment (OTA), 1981). In 1980, total exports reached 92 million tons, a 39 percent increase over 1979. Industry projections for the year 2000 run as high as 280 million tons, based on a steadily increasing world demand for coal as a replacement for oil (OTA, 1981). It is the consensus of the coal industry, however, that these levels will never be obtained unless the U.S. ports involved in coal export are modernized and deepened in order to handle the new, larger colliers now being produced and the super colliers projected for the future (OTA, 1981). At a minimum, it appears that channels of 50- to 55-foot depths must be available if a port is to remain competitive in this market. Presently, the coal export facilities in both Baltimore and Norfolk are inadequate to handle even the existing traffic, and long lines of colliers at anchor in the bay are a common sight (OTA, 1981).

In the Baltimore area alone future expansion of the port may well require the deepening of channels from roughly the Bay Bridge to Baltimore Harbor, and from the harbor to the Chesapeake and Delaware Canal (Farragut, 1981). In the next twenty years this could lead to the dredging of 120 million cubic yards of material just in this one portion of the bay, assuming development of a 50-foot channel. (According to comments on the draft report by the Maryland Department of Resources, dredging in this region of the bay below the authorized depth of 35 feet could be precluded due to the possibility of cutting through ground water aquifers.) About one half of the material would originate within the harbor. Fifty million cubic yards would be due to new channel work, 32 million cubic yards would come from maintenance work, and the rest (38 million cubic yards) would result from private dredging activities (Farragut, 1981).

In addition to the two major commercial ports, there are a host of smaller facilities, both commercial and recreational, throughout the bay. Indeed, the 8,000 miles of shoreline, four major rivers, and 50 large tributaries of the Chesapeake Bay are the sites of one of the largest fishing and water-oriented recreation industries in the United States (U.S. Department of the Interior, 1970). While facilities associated with such activities do not require the water depths associated with commercial ports, they do generally necessitate some dredging, especially in the shallow embayments of the Chesapeake Bay.

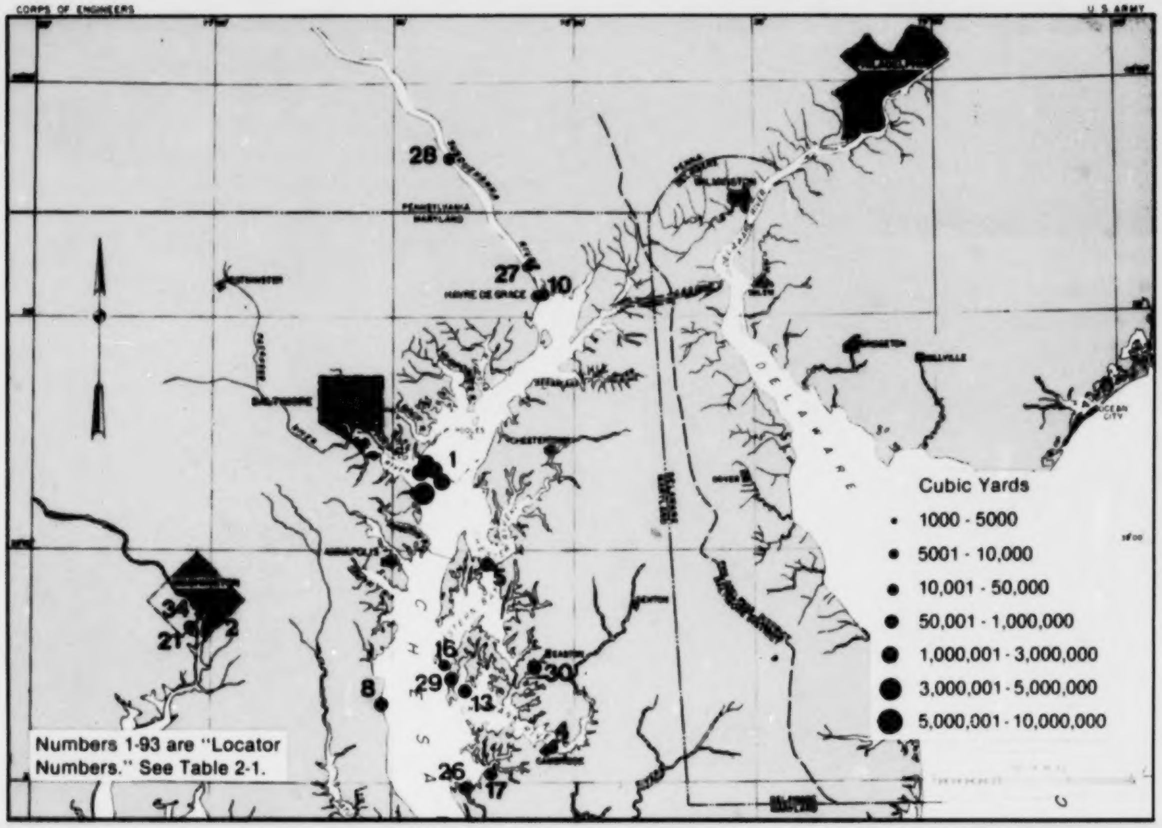
The dredging associated with all of these facilities is the source of environmental controversy. The issue of dredging polluted sediments and their subsequent disposal is particularly sensitive, and in the Chesapeake Bay has resulted in a delay of several years in the dredging of Baltimore Harbor. In addition, dredging and open water disposal, even of clean material, generates turbidity and disturbs benthic habitat. This has also been a source of concern within the bay, particularly for large projects in areas of the bay known to have a high ecological value, such as fish spawning areas or shellfish beds. The selection of disposal sites is also a major issue, one that will become more controversial as existing sites become filled.

While all of these concerns are legitimate and deserve to be addressed, it is equally clear that the economic viability of the region requires that dredging projects be carried out. Therefore, decisions must be made, based on all of these conflicting demands and concerns, in order to provide the best possible protection for the ecological systems of the bay, while still maintaining reasonable access for commercial and recreational users. Any such consensus has been difficult to reach in the past, partly due to a lack of readily accessible information on dredging practices and technologies as they relate to the Chesapeake Bay. This report is intended at least partially to fill that gap in understanding the problems of the bay.

2.0 COMPILATION AND REVIEW OF DREDGING RECORDS FOR THE CHESAPEAKE BAY

Regulation of dredging in the Chesapeake Bay and its tributaries on the federal level is the responsibility of three districts of the U.S. Army Corps of Engineers (COE): Philadelphia, Baltimore, and Norfolk. In this capacity they maintain extensive permit and project records. The Philadelphia District is responsible for dredging only the approach channels to the Chesapeake and Delaware Canal. While the volume of material involved in this operation is large, 8.6 million cubic yards from 1973 to 1979, according to a review comment by the Maryland Tidewater Administration, the geographic area involved is small. In addition, no private permit work falls under their jurisdiction. An analysis of dredging data from the Philadelphia District was not included in the scope of this report, and data from those projects will not be discussed. The remaining two districts are responsible for all other federal projects in the bay and regulate all non-federal activity. The Baltimore District is responsible for all waters entering the bay north of, and including, the Potomac River Basin, as well as the Maryland and Delaware portion of the Eastern Shore not included in the Delaware Bay drainage. The Norfolk District is responsible for the remainder of the bay (Figures 2-1 and 2-2).

In order to obtain the necessary data to define current dredging practices in the Chesapeake Bay a comprehensive survey of the dredging records and permit files of the Baltimore and Norfolk Districts was conducted. Both districts maintain their records on a fiscal year (FY) basis, and therefore all data in this report are presented on that basis. Prior to 1976, the federal fiscal year ran from 1 July until 30 June. In 1976 there was a transition quarter from 1 July through 30 September, after which the federal fiscal year became 1 October through 30 September. In this report data from the transition quarter are included with FY 1975. For federal projects, records from FY 1970 to FY 1980 (inclusive) were reviewed. For permit applications (non-federal projects) the number (an average of 150 to 200 per year for the two districts combined) was so extensive that the analysis was restricted to the period FY 1975 through FY 1980 (inclusive). The data obtained in this survey are presented in Appendix A as Tables A-1 through A-22 (federal projects) and Tables A-23 through A-34 (non-federal projects). Summaries of this information are included in this section and are used to characterize the location and size of dredging projects, the costs associated with dredging, disposal locations and methods, and utilization of dredging equipment.


CORPS OF ENGINEERS
U.S. ARMY
28
PENNSYLVANIA
MARYLAND
27
HAVRE DE GRACE
10
1
DELAWARE
OCEAN CITY
34
21
2
5
8
15
29
30
13
4
26
17
C
H
E
S
A
Cubic Yards
1000 - 5000
5001 - 10,000
10,001 - 50,000
50,001 - 1,000,000
1,000,001 - 3,000,000
3,000,001 - 5,000,000
5,000,001 - 10,000,000

Numbers 1-93 are "Locator Numbers." See Table 2-1.

FIGURE 2-1
LOCATION OF VOLUMES ASSOCIATED WITH DREDGING IN FEDERALLY MAINTAINED CHANNELS IN THE NORTHERN PORTION OF THE CHESAPEAKE BAY REGION, FISCAL YEAR 1970 THROUGH FISCAL YEAR 1980

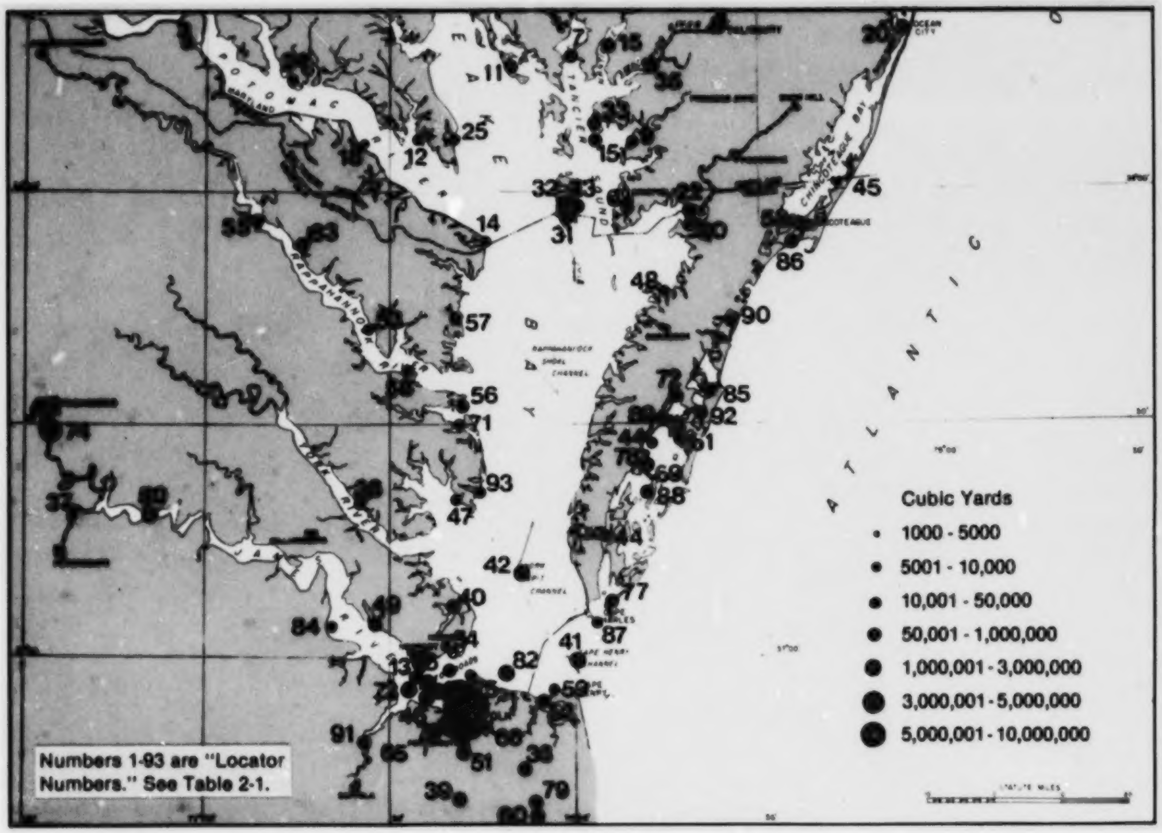

Cubic Yards
● 1000 - 5000
● 5001 - 10,000
● 10,001 - 50,000
● 50,001 - 1,000,000
● 1,000,001 - 3,000,000
● 3,000,001 - 5,000,000
● 5,000,001 - 10,000,000
Numbers 1-93 are "Locator Numbers." See Table 2-1.
POTOMAC RIVER
MARYLAND
RAPPAHANNOCK RIVER
YORK RIVER
TANGIER SOUND
CHINCOTEAGUE BAY
OCEAN CITY
CHINCOTEAGUE
RAPPAHANNOCK SHOAL CHANNEL
CHANNEL
CAPE HENRY CHANNEL
ATLANTIC O
B A Y
STATUTE MILES
20
7
15
11
36
25
12
33
151
45
32
31
14
22
55
63
86
48
57
90
56
72
85
71
92
51
93
69
88
47
44
42
77
40
49
84
87
41
82
13
59
91
65
66
38
39
79
74
37

FIGURE 2-2
LOCATION OF VOLUMES ASSOCIATED WITH DREDGING IN FEDERALLY MAINTAINED CHANNELS IN THE SOUTHERN PORTION OF THE CHESAPEAKE BAY REGION, FISCAL YEAR 1970 THROUGH FISCAL YEAR 1980

There were two assumptions made concerning the data which could influence the conclusions of the report. These are:

- It is assumed that the volume listed on any permit or project description was dredged in the year of issue, unless otherwise indicated.
- If two or more equipment types or disposal options were listed, without clear indication as to how the dredging was apportioned, the data were assigned to the category listed first.

In some cases data entries were missing for a particular project or permit. When that occurred that particular entry was not included in the total number of data points for calculations of average values.

In addition to this survey of federal records, four dredging companies responsible for much of the federal dredging done under contract in the Chesapeake Bay were contacted for information on costs, equipment available, and general comments on the issues surrounding dredging in the Chesapeake Bay. Information obtained from these sources is included throughout the report. A tabulation of all dredging equipment available for use in the Chesapeake Bay, and a limited description of each was prepared based on these interviews and is included as Appendix B.

2.1 Location and Size of Dredging Projects

2.1.1 Federal Projects

There are approximately 150 federal projects authorized within the two districts, ranging in size from the extensive Baltimore and Norfolk approach channels (40 to 50 feet deep and 600 feet or more in width) to Accotink Creek in Virginia (four foot depth and 25 to 40 feet in width). The main commercial navigation channels are grouped under five project authorizations: Baltimore Harbor and Channel (Norfolk District Project No. 8, Baltimore District Project No. 1), the channel to Newport News (Norfolk District Project No. 47), Norfolk Harbor (Norfolk District Project No. 56), and Thimble Shoal Channel (Norfolk District Project No. 60). Of the 145 other projects, 15 authorized for construction have been deferred for various reasons, 13 remain to be completed, and a large number either do not require or cannot justify regular maintenance.

During the eleven fiscal years included in this survey, 35 federal projects in the Baltimore District and 58 in the Norfolk

District were dredged at least once (Tables 2-1 and 2-2). Eighteen of these projects contributed 500,000 cubic yards or more of dredged material each in the eleven-year period, for a total of approximately 55 million cubic yards, or 86 percent of the 63.9 million cubic yards dredged from federal projects. An additional ten projects produced between 250,001 and 500,000 cubic yards, and, if the two categories are combined, these 28 projects were responsible for 58.7 million cubic yards, or 92 percent of the eleven-year total for federal projects. Almost all of this material has been produced by dredging in either the Baltimore or Norfolk-Hampton Roads harbor complexes, or in the Baltimore Channel projects in the main stem of the bay. Figures 2-1 and 2-2 show the locations of all the federal projects dredged during the period reviewed. The total volume dredged at each location is indicated by the relative size of the locator dots, which are numerically keyed to the projects listed in Tables 2-1 and 2-2. Overall, there has been more activity in the Norfolk District, where 53 million cubic yards were dredged, as opposed to 10.9 million cubic yards in the Baltimore District.

The distribution of the annual volumes of material removed from the various federal projects is shown in Table 2-3. Very few federal projects, when they are dredged, produce an annual volume of less than 10,000 cubic yards. In the Baltimore District, 65 percent of the observed annual volumes fell in the range of 10,001 to 100,000 cubic yards, and no project produced an annual volume of more than 1,000,000 cubic yards. In the Norfolk District only 39 percent of the observed annual volumes were between 10,001 and 100,000 cubic yards, and there were many more large projects. In the Baltimore District values over 250,000 cubic yards constituted only 20 percent of the total, while in the Norfolk District they made up 42 percent of the observations.

Interestingly, there was only one new work project undertaken in the Baltimore District in the entire eleven-year period, while a wide range of new work initiatives were undertaken in the Norfolk District. These generally involved the expansion of an existing project (Tables A-1 through A-22).

The annual volume of dredged material produced from federal projects in both districts is shown in Figure 2-3, based on the summary data presented in Tables 2-4 and 2-5. Over the last eleven years, 10.9 million cubic yards of material have been dredged by the Corps of Engineers and private contractors in federally maintained channels in the Baltimore District; of this total amount, 4.1 cubic yards were dredged by the Corps of Engineers' vessels while 6.8 million cubic yards of material were dredged by private

TABLE 2-1

FEDERAL DREDGING PROJECTS IN THE BALTIMORE DISTRICT, FISCAL YEARS 1970 THROUGH 1980

LOCATOR NUMBER ON FIGURE 2-1 OR 2-2	PROJECT	DISTRICT PROJECT NO.	GROSS YARDAGE (cubic yards)											
			1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	Total
1	Baltimore Harbor, MD	1	496,879		310,403			299,506	608,300					1,715,088
	-Cutoff Brewerton Angle													
	-Craighill Cutoff Angle		384,433	371,602	471,830			558,710		623,624	615,350		615,000	3,640,549
	-Connecting Channel (incl. Swann Point and Tolchester)		157,422										872,340	1,029,762
	-Cutoff Section		237,320	301,706										539,026
	-Brewerton Section Cutoff			508,938										508,938
2	Anacostia River and Tributaries, MD	104	83,300				96,000						61,000	240,300
3	Bonum Creek, MD	118	3,959											3,959
4	Cambridge Harbor, MD	30									79,775			79,775
5	Chester River, MD	10	30,655				51,364			30,315				112,334
6	Crisfield Harbor, MD	48										54,250		54,250
7	Fishing Bay, MD	36									94,120			94,120
8	Fishing Creek, MD	60		82,200						55,670				137,870
9	Goose Creek, MD	46			45,045									45,045
10	Havre de Grace, MD					20,200								20,200
11	Honga River & Tar Bay, MD	33					47,200			75,300				122,500
12	Island Creek, St. George Island, MD	25	12,235									22,220		34,455
13	Knapps Narrows, MD	18						77,600		43,500			75,596	196,746
14	Little Wicomico River, VA										25,640			25,640
15	Lower Thorofare, Deal Island, MD	44	44,300									101,046		145,346
16	Lowes Wharf, MD	15	15,300											15,300
17	Madison Bay, MD	32A							54,400					54,400
18	Monroe Bay & Creek, MD			5,500										5,500
19	Nanticoke River, MD	40	42,000				32,925		70,000					144,925
20	Ocean City, Harbor and Inlet and Sinepuxent Bay, MD		41,900		110,500	100,800		38,200	30,336		44,800	60,614	38,636	465,786
21	Pentagon Lagoon, MD										25,400			25,400
22	Pocomoke River, MD	50									111,507			111,507
23	Rhodes Point to Tylerton, MD	54	107,711							40,910				148,621
24	St. Catherine Sound, MD											22,052		22,052
25	St. Jerome Creek, MD	55	40,100											40,100
26	Slaughter Creek, MD	32					13,000							13,000
27	Susquehanna River above and below Havre de Grace, MD	4				30,922								30,922
28	Susquehanna River at Williamsport, PA	5				50,000								50,000
29	Tilghman Harbor, MD	20	64,700										23,500	88,200
30	Tred Avon River, MD	22						215,000						215,000
31	Twitch Cove and Big Thorofare, MD	53	14,200	51,900			9,957		80,950	26,530				183,537
32	Tyler River, MD	34								18,310				18,310
33	Upper Thorofare, Deal Island, MD	43							65,035					65,035
34	Washington Harbor	101											3,583	3,583
35	Wicomico River, MD	42							362,200		90,463			452,663
	TOTAL		1,776,414	1,321,846	937,778	201,922	250,446	1,189,016	1,271,221	914,309	1,087,055	260,182	1,689,655	10,899,744

TABLE 2-2

FEDERAL DREDGING PROJECTS IN THE NORFOLK DISTRICT, FISCAL YEARS 1970 THROUGH 1980

LOCATOR NUMBER ON FIGURE 2-1 OR 2-2	PROJECT	DISTRICT PROJECT NO.	GROSS YARDAGE (cubic yards)											
			1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
36	Aberdeen Creek, VA	40						50,426						50,426
37	Appotamox River, VA	50			36,011									36,011
38	Atlantic Intercoastal Waterway, Deep Creek Canal VA	63c	232,455	102,440	105,525		232,054						4,694	667,168
39	Atlantic Intercoastal Waterway, South Branch, VA	63	483,850											483,850
40	Back River, Langley Field, VA	44											54,703	54,703
41	Baltimore Harbor and Channels: Cape Henry, VA	8	538,750		369,178		105,346							1,013,274
42	Baltimore Harbor and Channels: York Spit, VA	8	454,333			532,100				216,359				1,202,792
43	Channel to Newport News, VA	47	114,352	295,100		207,800		97,253						714,505
44	Chesapeake Bay to Magothy Bay, VA	6			58,840									58,840
45	Chincoteague Inlet, VA	10							69,390				79,834	149,224
46	Craney Island, VA					845,287					1,233,877			2,079,164
47	Davis Creek, VA	39		45,367										45,367
48	Deep Creek, VA	15	5,180											5,180
49	Deep Creek, Newport News, VA	49								42,864	33,422		255,975	332,261
50	Deepwater Terminal and Shoals below Hopwell, VA	51				1,181,040								1,181,040
51	Dismal Swamp Canal Feeder Ditch, VA	63	20,973			24,304					34,933		68,630	148,840
52	Entrance to Channel and Basin Lynnhaven, Inlet, VA	62		114,386		94,556					94,177			303,119
53	Greenvale Creek, VA	22			34,112						15,797			49,909
54	Hampton Creek and Approach Channel, VA	46					26,324							26,324
55	Hoskins Creek, VA	26			127,192									127,192
56	Jackson Creek, VA	34	203,099											203,099
57	Jarvis Creek, VA	18							22,398					22,398
58	Lewis Creek and Chincoteague Bay, VA	1			25,645									25,645
59	Long Creek to Broad Bay, VA	62		28,133										28,133
60	Lower North Landing VA	63			337,911									337,911
61	Magothy Bay, Sloop Channel, VA	6									291,075			291,075
62	Mooring Area, West of Great Bridge Lock, VA	63									9,562			9,562
63	Newport News Anchorage, VA	47			3,814,194								967,382	4,781,576
64	Norfolk Harbor, VA	56		1,167,133	1,196,300	400,084	429,722	491,372	1,131,540		318,825	422,359	1,521,383	7,078,718
65	Norfolk Harbor, 45' Channel, VA	56		78,336		38,733		794,651	1,004,809		338,740	450,284		2,705,553
66	Norfolk Harbor, East & West Anchorages, VA	56				576,760							1,301,406	1,878,166
67	Norfolk Harbor in the vicinity of the Navy Degaussing Range, VA	56		282,211										282,211
68	Norfolk Harbor, South Branch, VA	56					621,804							621,804
69	North Channel, VA	6						99,194						99,194
70	Oyster Channel, VA	7		41,954										41,954
71	Queens Creek, VA	36										10,951		10,951
72	Quinby Creek, VA	4				107,352				85,585				192,937
73	Rehandling Basin, VA		662,909			845,287							1,300,000	2,808,196

TABLE 2-2 (concluded)

FEDERAL DREDGING PROJECTS IN THE NORFOLK DISTRICT, FISCAL YEARS 1970 THROUGH 1980

LOCATOR NUMBER ON FIGURE 2-1 OR 2-2	PROJECT	DISTRICT PROJECT NO.	GROSS YARDAGE (cubic yards)											
			1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
74	Richmond Harbor, VA	51		1,176,305	1,193,306		688,761	1,022,209	530,828		165,503			4,776,912
75	Seaways Pier Area, Town Point Beach, VA	56										13,644		13,644
76	Sewells Point Anchorage, VA	56		8,968,092						550,116				9,518,208
77	Skiffes Creek, Fort Eustis, VA							263,962				143,747		407,709
78	Smith Creek, VA						37,062							37,062
79	Southern Branch of Elizabeth River, VA	56						211,549					3,372,160	3,583,709
80	Starling Creek, VA	16		23,682			48,724					57,200		129,606
81	Tangier Channel, VA	17	78,528			81,622	81,139				86,416		52,698	380,403
82	Thimble Shoal Channel, VA	60	358,960			789,635		1,129,143						2,277,738
83	Totuskey Creek, VA	24	235,432											235,432
84	Tylers Beach, Isle of Wight, VA	52			29,363									29,363
85	Waterway on Coast of Va: Bradford Bay, VA	63								67,505				67,505
86	Waterway on Coast of VA and Chincoteague Channel, VA	63				409,306	285,461							694,767
87	Waterway on Coast of VA: Fisherman's Island, VA	63								23,195				23,195
88	Waterway on Coast of VA: Gull Marsh, VA	63							170,971					170,971
89	Waterway on Coast of VA: Little Machipongo River, VA	63			218,407									218,407
90	Waterway on Coast of VA: Metomkin Bay, VA	63					18,557							18,557
91	Western Branch of Nansemond River, VA	55									52,342			52,342
92	White Trout Creek, Swash Bay, VA	6									160,200			160,200
93	Winter Harbor, VA	37										40,426		40,426
	TOTAL		3,388,821	12,121,119	7,543,986	6,131,866	2,334,954	4,159,759	2,929,916	985,624	2,836,869	1,138,611	8,978,863	52,994,428

TABLE 2-3

FREQUENCY DISTRIBUTION OF THE VOLUME OF MATERIAL DREDGED ANNUALLY FROM FEDERAL PROJECTS IN THE BALTIMORE AND NORFOLK DISTRICTS, FISCAL YEARS 1970 THROUGH 1980

	Baltimore District				Norfolk District			
Volume Dredged (cubic yards)	No. of Events*	% of Total No.	Total Volume (cubic yards)	% of Total Vol.	No. of Events	% of Total No.	Total Volume (cubic yards)	% of Total Vol.
1 - 1000	0	0	0	0	0	0	0	0
1001 - 10,000	4	5	22,999	1	5	4	23,236	<1
10,001 - 50,000	30	38	936,091	8	24	19	740,931	1
50,001 - 100,000	21	27	1,499,573	14	25	20	1,855,748	3
100,001 - 250,000	8	10	1,245,962	11	19	15	3,161,288	6
250,001 - 500,000	9	12	3,301,795	30	21	17	7,687,917	15
500,001 - 1,000,000	6	8	3,893,324	36	17	14	12,054,247	23
1,000,001 - 5,000,000	0	0	0	0	13	10	18,502,969	35
5,000,000 +	0	0	0	0	1	1	8,968,092	17
TOTALS	78	100	10,899,744	100	125	100	52,994,428	100

*An event, for a federal project, represents the total volume authorized for removal in a given fiscal year, for a specific project.

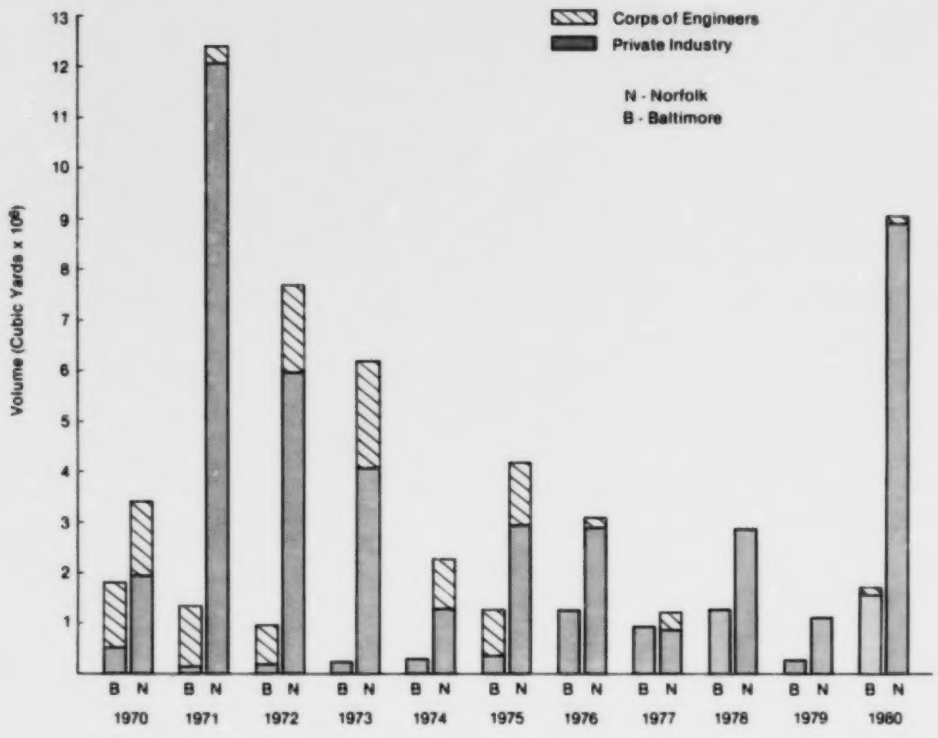


FIGURE 2-3
VOLUME OF MATERIAL DREDGED ANNUALLY FROM FEDERAL PROJECTS IN THE BALTIMORE AND NORFOLK DISTRICTS, FISCAL YEARS 1970 THROUGH 1980

TABLE 2-4

A SUMMARY OF VOLUME AND COST DATA FOR DREDGING IN THE BALTIMORE DISTRICT, FISCAL YEARS 1970 THROUGH 1980

YEAR	FEDERAL PROJECTS PERFORMED BY CORPS OF ENGINEERS			FEDERAL PROJECTS PERFORMED BY PRIVATE CONTRACTORS			PRIVATE PROJECTS
	TOTAL AMOUNT DREDGED (cubic yards)	TOTAL COST[1] (dollars)	AVERAGE COST[2] (dollars/cubic yard)	TOTAL AMOUNT DREDGED (cubic yards)	TOTAL COST[1] (dollars)	AVERAGE COST[2] (dollars/cubic yard)	TOTAL AMOUNT DREDGED[3] (cubic yards)
1970	1,276,054	289,655	0.23	500,360	614,398	1.23	
1971	1,182,246	326,157	0.28	139,600	143,614	1.03	
1972	782,233	321,896	0.41	155,545	196,067	1.26	
1973	0	0		201,922	334,611	1.66	
1974	0	0		250,446	621,777	2.48	
1975*	858,216	573,084	0.67	330,800	667,956	2.02	2,019,051
1976	0	0		1,271,221	1,868,599	1.47	1,198,168
1977	0	0		914,209	1,580,756	1.73	1,726,386
1978	0	0		1,087,055	3,484,888	3.21	505,595
1979	0	0		260,182	1,074,983	4.13	2,627,490
1980	3,583	44,241	12.35[4]	1,686,072	5,009,531	2.97	4,076,929
TOTAL	4,102,332	1,555,033	0.40	6,797,412	15,597,180	2.29	12,153,619

[1] Includes mobilization/demobilization costs.

[2] Cost of dredging itself, doesn't include mobilization and demobilization costs.

[3] Data collected from 1975 to 1980 only.

[4] Represents only one (1) project.

* Includes Transition Quarter

TABLE 2-5

A SUMMARY OF VOLUME AND COST DATA FOR DREDGING IN THE NORFOLK DISTRICT, FISCAL YEARS 1970 THROUGH 1980

YEAR	FEDERAL PROJECTS PERFORMED BY CORPS OF ENGINEERS			FEDERAL PROJECTS PERFORMED BY PRIVATE CONTRACTORS			PRIVATE PROJECTS
	TOTAL AMOUNT DREDGED (cubic yards)	TOTAL COST[1] (dollars)	AVERAGE COST[2] (dollars/cubic yard)	TOTAL AMOUNT DREDGED (cubic yards)	TOTAL COST[1] (dollars)	AVERAGE COST[2] (dollars/cubic yard)	TOTAL AMOUNT DREDGED[3] (cubic yards)
1970	1,466,395	1,498,040	1.02	1,922,426	1,236,584	0.64	
1971	295,100	352,834	1.20	12,028,039	5,592,411	0.46	
1972	1,565,478	1,065,080	0.68	5,980,506	4,616,247	0.77	
1973	2,106,295	1,981,631	0.94	4,027,571	2,212,939	0.55	
1974	1,099,297	702,923	0.64	1,475,657	1,916,535	1.30	
1975*	1,226,396	1,746,078	1.42	2,933,363	2,293,220	0.78	1,692,632
1976	69,390	183,927	2.65	2,860,546	2,551,619	0.89	1,129,339
1977	259,223	900,054	3.47	820,578	1,191,737	1.45	2,856,640
1978	0	0		2,740,692	3,629,436	1.32	840,465
1979	0	0		1,138,611	1,885,521	1.66	1,482,014
1980	79,834	435,114	5.45	8,899,031	11,389,402	1.28	7,211,587
TOTAL	8,167,408	8,865,681	1.09	44,827,020	38,513,651	0.86	15,212,677

[1] Includes mobilization/demobilization costs.

[2] Cost of dredging itself, doesn't include mobilization and demobilization costs.

[3] Data collected from 1975 to 1980 only.

* Includes Transition Quarter

contractors. In the Norfolk District, 53 million cubic yards of material were dredged in the same period, with 8.2 million cubic yards credited to the Corps of Engineers' dredging fleet and 44.8 million cubic yards credited to various private dredging companies. In all years the volume of material dredged in the Norfolk District is greater than in the Baltimore District, generally much greater. Additionally, the amount of work done by federally-owned dredges on federal projects has declined drastically and the annual volume has varied considerably in both districts.

In the Baltimore District, the volume dredged decreased from FY 1970 to FY 1973, remained approximately the same in FY 1973 and FY 1974, increased in FY 1975 and FY 1976, decreased in the next three fiscal years, and then increased again in FY 1980. The relatively large amount of material dredged in FY 1976 appears attributable to the additional work resulting from the effects of tropical storm Eloise in 1975. The slowdown in dredging activities for federal projects in FY 1979 at least partially reflects the decision by the Corps of Engineers to postpone any dredging work in the port of Baltimore, following tests on sediments from Swann Point and Tolchester channels in 1978 by the Maryland Department of Natural Resources. The results showed high levels of PCBs as well as chlordane (McKee 1982). A study conducted by Enviroplan Inc. in 1980 for the Baltimore District, showed no significant amount of pesticides in the Baltimore Harbor and scheduling of dredging activities resumed. The Swan Point Channel, which was scheduled to be deepened in FY 1979 was actually dredged in FY 1980 (and widened in FY 1981), which contributes to the increase in dredging activities in FY 1980 (McKee, 1981). The declining role played by the Corps of Engineers fleet is a result of the Industry Capability Program and Public Law 95-269 which encourages private dredgers to take a more active role in dredging activities, by competing with the Corps of Engineers through the bidding procedures (Murden, 1980).

In the Norfolk District, while the volumes removed from federal projects are always greater than in the Baltimore District, the variations are much more dramatic. Dredging activities decreased from FY 1971 to FY 1979, the most active fiscal years for dredging being 1971 and 1980. The slowdown in dredging activities can be attributed to environmental constraints and limited funding (Whitehurst, 1981). Kepone contamination of the James River led to cessation of all dredging there in 1975. At the present time consideration is being given to the resumption of dredging in this area, with suitable environmental safeguards and the allocation of additional funding. According to Whitehurst (1981) dredging is expected to resume in some form in FY 1981 or FY 1982. As in the Baltimore District, the role of federally owned dredges has declined.

2.1.2 Non-Federal Projects

The Corps of Engineers is also responsible for the regulation of non-federal dredging activities. This includes work by industrial corporations, individual property owners, public marinas, utilities, state and local governments, and federal entities dredging areas other than those channels designated for maintenance by the Corps. As a result, for every proposed dredging project a permit application is filed with the appropriate district office. These are kept indefinitely and include data on location, type of project, volume of dredged material, disposal, and equipment used. They do not include information on project costs. Initially, it was intended that all permits issued in both districts from FY 1970 through FY 1980 be reviewed and included in this report. However, the number of permits requested annually (over 150 in the two districts combined) necessitated the restriction of our analysis to the period from FY 1975 through FY 1980.

Figure 2-4 summarizes the statistics on the volumes of material dredged on non-federal projects. Over the six years, the Corps of Engineers issued 648 dredging permits in the Baltimore District; 645 permits indicate the quantity of material dredged, which totaled 12.2 million cubic yards, or an average of nearly 19,000 cubic yards per permit. However, most of these projects involved very small amounts of material, between one and 1,000 cubic yards (Table 2-6). In the same period only 354 dredging permits were issued by the Norfolk District; 352 of these permits indicate the quantity of dredged material, which totaled 15.2 million cubic yards, or an average of about 43,000 cubic yards per permit (Table 2-6). In the Norfolk District there were more very large non-federal projects, with ten projects of between 250,001 and 1,000,000 cubic yards, and three projects of over 1,000,000 cubic yards. In the Baltimore District the values for the same size classes were four and one, respectively. As would be expected, most of the larger projects were associated with commercial port expansion or maintenance. The smaller projects were scattered throughout the bay.

In both districts there was a considerable increase in the volume of non-federal work authorized in 1980. This appears to be attributable mainly to two factors: improved permit processing procedures, and the pressures of an ever-increasing backlog of deferred projects. Discussions with both districts suggest that any type of trend analysis would be inappropriate, since the limiting factors are continually changing.

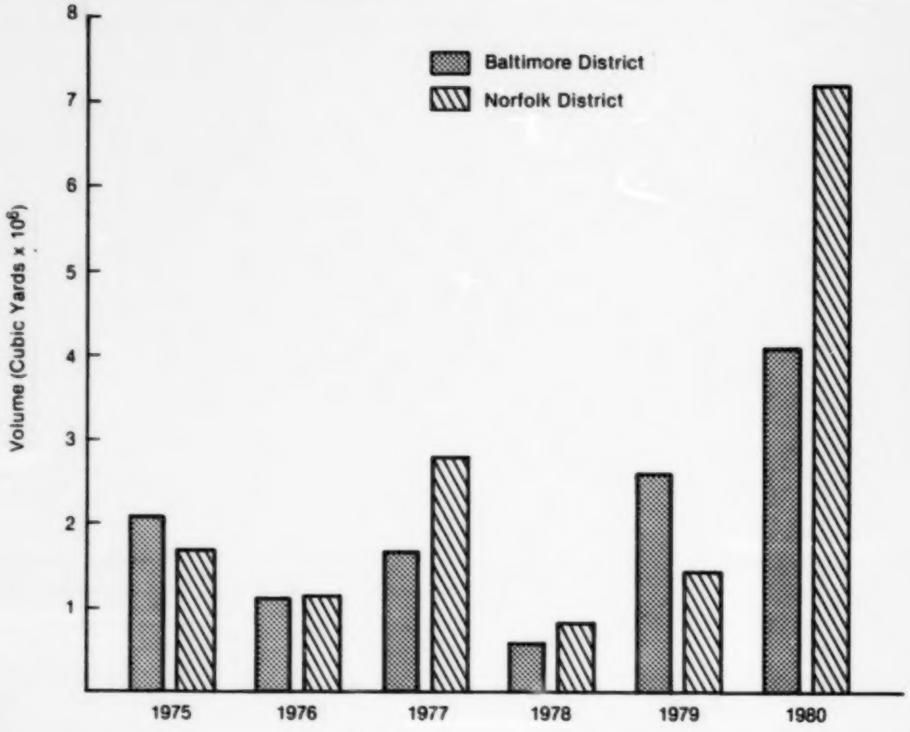


FIGURE 2-4
VOLUME OF MATERIAL DREDGED ANNUALLY FROM NON-FEDERAL PROJECTS IN THE BALTIMORE AND NORFOLK DISTRICTS, FISCAL YEARS 1975 THROUGH 1980

TABLE 2-6

FREQUENCY DISTRIBUTION OF THE VOLUME OF MATERIAL DREDGED PER PERMIT IN NON-FEDERAL PROJECTS IN THE BALTIMORE AND NORFOLK DISTRICTS, FISCAL YEARS 1975 THROUGH 1980

	Baltimore District				Norfolk District			
Volume Dredged (cubic yards)	No. of Permits	% of Total No.	Total Volume (cubic yards)	% of Total Vol.	No. of Permits	% of Total No.	Total Volume (cubic yards)	% of Total Vol.
1 - 1000	361	56	128,476	1	199	56	59,462	<1
1001 - 10,000	171	27	621,164	5	81	23	299,642	2
10,001 - 50,000	79	12	1,761,589	15	36	10	902,682	6
50,001 - 100,000	16	2	1,248,750	10	9	3	694,400	5
100,001 - 250,000	13	2	1,803,640	15	14	4	2,166,391	14
250,001 - 500,000	0	0	0	0	6	2	2,167,100	14
500,001 - 1,000,000	4	<1	3,190,000	26	4	1	2,381,000	16
1,000,001 - 5,000,000	1	<1	3,400,000	28	3	1	6,542,000	43
5,000,000+	0	0	0	0	0	0	0	0
TOTALS	645	100	12,153,619	100	352	100	15,212,677	100

2.2 Utilization of Dredging Equipment

2.2.1 Federal Projects

Dredging in federal projects relied overwhelmingly on the use of large hydraulic dredges (Tables A-1 through A-22). Overall, only six percent of the material produced from federal projects was generated by equipment other than hydraulic dredges. In the Norfolk District 52.6 million cubic yards were dredged by hydraulic equipment (mostly cutterhead suction dredges ranging in size from 12 to 27 inches), while only 0.4 million cubic yards were excavated using mechanical methods (mostly clamshell-type dredges). In the Baltimore District, of the 10.9 million cubic yards dredged, 3.4 million cubic yards were excavated by mechanical methods (again, mostly clamshell dredges), while the rest, 7.5 million cubic yards, was excavated by hydraulic means, mostly cutterhead suction dredges.

2.2.2 Non-Federal Projects

A much wider range of equipment is used on non-federal projects than on federal ones (Table 2-7). This appears to be largely due to the wider range of equipment suitable for use on medium to small-sized projects. In the case of the Baltimore District 457 of the dredging permits reviewed indicate the method used for dredging; 368 were performed by mechanical means (clamshell, dragline, backhoe, dipper), and 89 by hydraulic methods (cutterhead suction). In the Norfolk District 330 permits indicated the method of dredging; mechanical methods were used in 275 cases and hydraulic equipment was indicated in 55 cases. In the Baltimore District mechanical equipment produced 70 percent of the volume dredged in the six-year period, while in the Norfolk District it produced only 29 percent of the volume (Table 2-7). This is due to the tendency to use hydraulic equipment for large projects (Table 2-8), and the greater number of large projects in the Norfolk District (Table 2-6). While bucket or clamshell dredges were used on very small projects as well as those in excess of 1,000,000 cubic yards, draglines are almost never used on projects over 10,000 cubic yards. Other construction equipment, such as backhoes and cranes, were listed only on very small projects.

2.3 Cost of Dredging

2.3.1 Federal Projects

From 1970 to 1980, 63.9 million cubic yards of material were dredged from federal projects in the two districts at a total cost of 64.5 million dollars. The overall average cost per cubic yard

TABLE 2-7

VOLUME OF MATERIAL DREDGED, BY TYPE OF EQUIPMENT ON NON-FEDERAL PROJECTS IN THE CHESAPEAKE BAY REGION, FISCAL YEARS 1975 THROUGH 1980

Type of Equipment	Baltimore District No. of Permits	% of Total No.	Total Volume of Material (cubic yards)	% of Total Volume	Norfolk District No. of Permits	% of Total No.	Total Volume of Material (cubic yards)	% of Total Volume
Hydraulic	91	20	1,751,896	30	55	17	10,537,572	71
Bucket/Clamshell	198	43	3,611,442	62	178	54	4,090,751	28
Dragline	140	31	399,833	7	92	28	201,398	1
Backhoe	22	5	20,148	<1	4	1	145	<1
Other General Construction	6	1	8,086	<1	1	<1	17	<1
Totals	457	100	5,791,405	100	330	100	14,829,883	100

TABLE 2-8

FREQUENCY DISTRIBUTION OF THE VOLUMES OF MATERIAL DREDGED ON NON-FEDERAL PROJECTS, BY TYPE OF DREDGING EQUIPMENT, IN THE BALTIMORE AND NORFOLK DISTRICTS, FISCAL YEARS 1975 THROUGH 1980

	Baltimore District				Norfolk District			
Volume Dredged (cubic yards)	Dragline	Bucket/ Clamshell	Hydraulic	Other	Dragline	Bucket/ Clamshell	Hydraulic	Other
1 - 1,000	94	109	13	23	66	105	9	5
1001 - 10,000	38	46	40	4	19	44	16	0
10,001 - 50,000	7	25	29	1	7	14	10	0
50,001 - 100,000	1	10	4	0	0	5	4	0
100,001 - 250,000	0	6	5	0	0	7	6	0
250,001 - 500,000	0	0	0	0	0	1	5	0
500,001 - 1,000,000	0	2	0	0	0	1	3	0
1,000,001 - 5,000,000	0	0	0	0	0	1	2	0
Total	140	198	91	28	92	178	55	5

for the entire period is $1.01, however, the annual data for each district indicates an irregular tendency towards increasing costs for both federal- and industry-dredged projects (Figure 2-5). Prior to Fiscal Year 1976, Corps of Engineers dredges appear to have been slightly less costly to operate on a per cubic yard basis; however, since that time costs associated with the use of Corps equipment have increased much more rapidly than those for private dredgers. This appears to be largely a result of the Industry Capability Program; Corps dredges are no longer routinely used on large federal projects. This has resulted in more efficient use of private dredges and has stimulated expansion and modernization of the private fleet. The high costs now associated with COE dredges reflect their relatively advanced age, and the small projects where they are now utilized (COE, 1979a; Murden, 1980). In addition, mobilization and demobilization costs represent much less of an incremental cost on large projects.

On the average, the cost per cubic yard for private contractors working on federal projects appears to have approximately doubled over the past ten years (see Tables 2-4 and 2-5). This increase can reasonably be explained on the basis of recent inflation rates. Costs for COE-operated dredges have increased more rapidly, apparently due to the size and nature of the projects and the age and condition of the equipment. However, costs associated with dredging are highly variable. In 1980, the last year included in this study, project costs in the Baltimore District ranged from $1.72/cubic yard to $12.35/cubic yard, while in the Norfolk District they ranged from $0.96/cubic yard to $5.45/cubic yard. In both cases the higher costs are generally associated with smaller projects (Tables A-11 and A-22).

2.3.2 Non-Federal Projects

Costs associated with non-federal projects are much more difficult to assess, since such information is not submitted to the Corps and would be obtainable only by contacting each permit applicant. Since that was beyond the scope of this project, information on such costs was solicited from several dredging companies working in the Chesapeake Bay region.

Disposal is almost always restricted to upland diked disposal sites, which implies that since disposal sites are not always available in the vicinity of the dredging site, additional transportation of the material is needed. The dredged material has then to be rehandled at the site itself. This operation significantly adds to the cost of dredging. Representatives of dredging companies generally assert that this has increased their

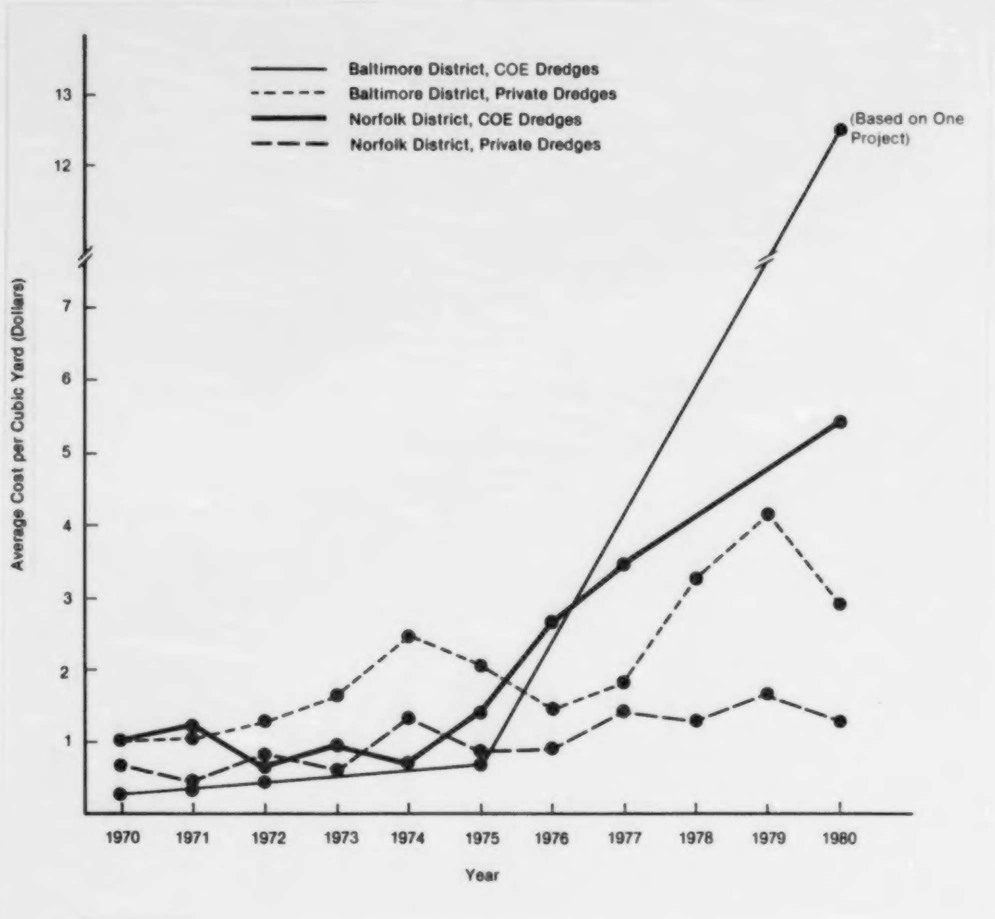


FIGURE 2-5
ANNUAL AVERAGE COST OF DREDGING ON FEDERAL PROJECTS IN THE BALTIMORE AND NORFOLK DISTRICTS, FISCAL YEARS 1970 THROUGH 1980

costs. No specific data were available in this study to evaluate this claim; however, increased costs for fuel and labor, as well as inflation, also must have played a role. In the Baltimore District, private dredging work totaling approximately 500,000 cubic yards of material was undertaken from 1978 through 1980 by the McLean Contracting Company, an engineering firm which specializes in marine and heavy construction projects and is equipped for dredging with clamshell buckets (three to seven cubic yards capacity). Their average cost per cubic yard (in 1980) of dredged material is about ten dollars, including transportation and disposal costs (Schwartz, 1980). According to Mr. Schwartz, a vice president of the McLean Company, a small project costing two dollars per cubic yard in 1970 could cost three times as much per cubic yard in 1980, and he attributed this to rehandling. Because the cost of mobilization and demobilization of the equipment is very high, private contractors usually try to combine federal and private work if they are located in the same area, in order to offer the permit holder a more competitive price (Holland, 1981).

Larger private projects are executed in a manner similar to federal dredging work. The project is first advertised in local newspapers, bids are received and evaluated by the permit holder, and the most competitive dredging company is chosen (Hull, 1981; Schwartz, 1980). Four major private dredging projects in the Chesapeake Bay undertaken by the Atkinson Dredging Company in the last five years are a fair representation of large private dredging projects contracted by big private companies (Table 2-9). The costs are comparable to those for large federal projects.

2.4 Disposal Methods

2.4.1 Federal Projects

Data on disposal methods used for federal projects are summarized in Table 2-10 and Figure 2-6. Out of the total of 63.9 million cubic yards dredged in the eleven-year period, 16 million (25 per cent) was disposed of in open water, with the rest going to upland disposal areas. Craney Island, a COE operated diked disposal area in the Norfolk District, received 36.2 million of the 47.9 million cubic yards not disposed of in open water.

In the Baltimore District, open water disposal constitutes a significant fraction of the total throughout the study period (7.9 million cubic yards, or 72 percent). The usual method used when dredging the approaches to the Baltimore Harbor has always been open water placement at sites approved by EPA and the responsible Maryland Agencies (see Section 3.2) (McKee, 1981). The Hart and

TABLE 2-9

EXAMPLES OF LARGE PRIVATE DREDGING PROJECTS PERFORMED BY A PRIVATE CONTRACTOR IN THE LAST FIVE YEARS*

Year	Permitee	Location	Total Amount Dredged (cubic **yards**)	Total Cost. (Dollars)	Cost per cu yd, mobilization and demobilization included (Dollars)
78	Delmarva Transport Committee	Baltimore Harbor Terminals	20,000	50,225	2.50
78	Fire Company	Norfolk	326,298	298,618	0.92
78	Va Port Authority	Norfolk	980,272	798,000	0.81
78	Maritime Terminal, Inc.	Norfolk	380,390	454,095	1.19

Source: Hull, 1981

TABLE 2-10

DISPOSAL OPTIONS FOR MATERIAL DREDGED FROM FEDERAL PROJECTS IN THE BALTIMORE AND NORFOLK DISTRICTS, FISCAL YEARS 1970 THROUGH 1980 VOLUMES IN CUBIC YARDS

	Baltimore District		Norfolk District			
Year	Volume Upland	Volume in Open Water	Volume Upland	Volume at Craney Island	Open Ocean	Volume in Other Open Water
1970	458,460	1,317,954	1,056,418	777,261	358,960	1,196,182
1971	57,400	1,264,446	1,532,267	10,790,872	0	0
1972	155,545	782,233	356,931	5,010,494	369,178	1,809,381
1973	80,922	121,000	1,381,522	2,913,951	789,635	1,048,758
1974	203,246	47,200	647,378	1,057,337	0	870,239
1975	253,200	935,816	1,548,146	1,383,276	1,129,143	99,194
1976	662,921	608,300	724,197	2,136,349	0	69,390
1977	290,585	623,624	202,957	592,980	0	283,864
1978	426,905	660,150	806,266	1,934,426	0	0
1979	260,182	0	252,324	886,287	0	0
1980	198,732	1,490,923	176,031	8,723,000	0	79,834
Total	3,048,098	7,851,646	8,684,437	36,206,233	2,646,916	5,456,842

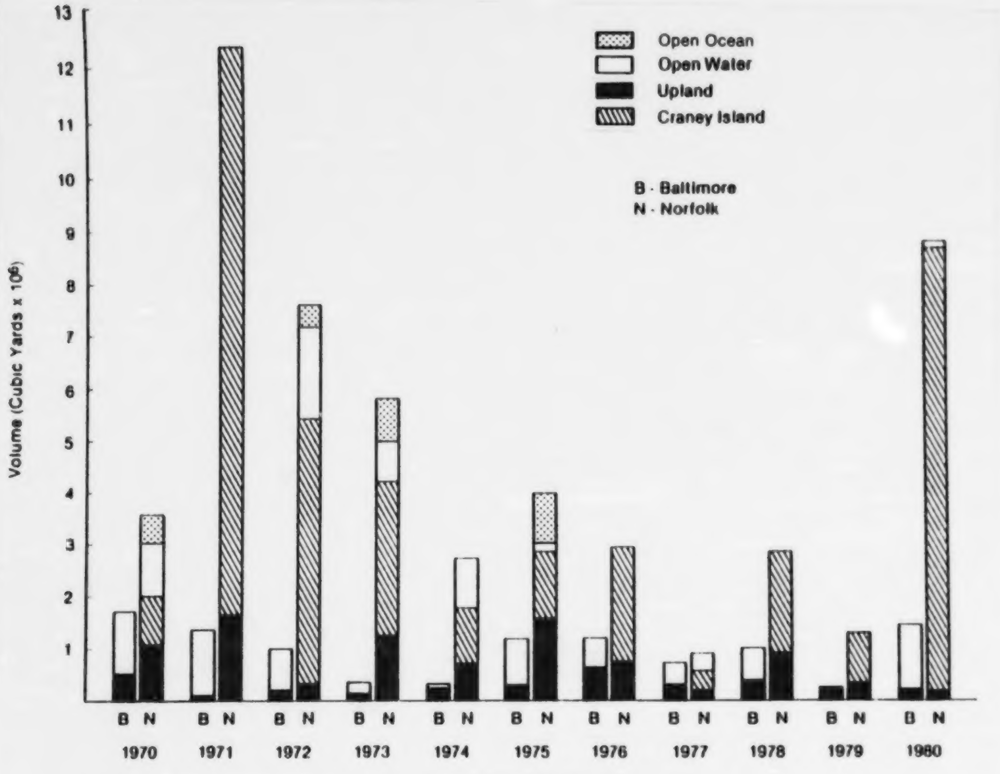


FIGURE 2-6
DISPOSAL OPTIONS FOR MATERIAL DREDGED FROM FEDERAL PROJECTS IN THE BALTIMORE AND NORFOLK DISTRICTS, FISCAL YEARS 1970 THROUGH 1980

Miller Island diked disposal site, when completed and in service (1983-1985), will have an eleven-year maintenance dredging capacity. The availability of this facility will obviously change current procedures, but the type of material it will actually be used for remains the subject of some discussion. Figure 2-6 is somewhat misleading since the open water volume is almost entirely controlled by the amount of material dredged in Baltimore Harbor and approaches, decreasing in 1973, 1974, and 1979 and increasing in 1975 and 1980. Trends in disposal practices are better shown if work in the Baltimore approach channels is omitted. It then becomes evident that, except in those areas, overboard disposal practices have been practically abandoned since 1976.

In the Norfolk District open water disposal has never been as significant on a percentage basis as it is in the Baltimore District, and has steadily declined since 1975, to be almost completely abandoned by 1980. The total volume, however, is significant. Over the eleven-year period, 8.1 million cubic yards were disposed of in this manner, 0.2 million more than in the Baltimore District. This was only 15 percent of the total for the district, however. As was stated earlier, the major disposal option for large projects in the Norfolk area has been placement at Craney Island.

The Craney Island disposal area is operated by the Norfolk District, Corps of Engineers, and provides a rehandling basin facility for bottom dump scows. The rehandling basin has been excavated to a 40-foot depth over a 1,000 foot square area. While clean material can be discharged into the rehandling area, contaminated material is discharged directly into the disposal area. The approach channels, 1,500 feet long by 200 feet wide, are maintained at an 18-foot depth (Cable, 1969). This facility is available to all private interests, municipalities, and government agencies engaged in dredging in Norfolk Harbor and other Hampton Roads areas. A toll charge is levied to cover the costs of amortization of the facilities, maintenance, and rehandling costs (Cable, 1969).

Upland disposal at sites other than Craney Island received 16 percent (8.7 million cubic yards) of the total volume dredged in the Norfolk District. These sites were generally selected due to their proximity to specific projects and may or may not have been used more than once.

2.4.2 Non-Federal Projects

Dredgers working on non-federal projects have a strong tendency to dispose of material at upland sites (Tables A-23 through A-34).

This is due to the relatively small size of most of the projects and to lack of access to open water disposal areas. In the Norfolk District a significant volume of material from larger non-federal projects in the Norfolk Harbor complex is taken to Craney Island, an option not available elsewhere in the bay.

In the Baltimore District approximately ten percent of the material dredged on private projects was disposed of in open water. Most of this was used for backfill over pipelines. The rest, about eleven million cubic yards, was taken to a wide range of upland disposal sites. On small projects, where shoreline dredging is involved, disposal on the property itself was very common.

In the Norfolk District, out of 15.2 million cubic yards, 10.9 million were placed in Craney Island. All but 16,000 of the remaining 4.3 million cubic yards went to other upland disposal areas.

3.0 REGULATORY PROGRAMS AFFECTING DREDGING IN THE CHESAPEAKE BAY

Dredging, as well as transporting and disposing of dredged material, is regulated by federal, state and local governments. This section briefly reviews legislation and implementing regulations which are most likely, at the federal, state and local levels, to affect dredging activities in the Chesapeake Bay area.

3.1 Federal Legislation and Regulations

Numerous federal statutes apply, either directly or indirectly, to dredging activities in the Chesapeake Bay. Of primary concern are the permitting authorities in:

- Section 401 of the Clean Water Act, as amended, (33 U.S.C. 1341),
- Section 404 of the Clean Water Act, as amended, (33 U.S.C. 1344),
- The River and Harbor Act of 1899 (33 U.S.C. 401 et seq.), and
- Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. 1413).

Related legislation includes: the Coastal Zone Management Act of 1972, as amended (16 U.S.C. 1451 et seq.); the Fish and Wildlife Coordination Act, as amended (16 U.S.C. 661 et seq.); the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.); the Safe Drinking Water Act of 1972 (42 U.S.C. 1401 et seq.); the Water Resources Planning Act (42 U.S.C. 1962c and 1962d); the Jones Act of 1920 (46 U.S.C., numerous sections) and Public Law 95-269, Amendments to the River and Harbor Appropriation Acts of 1899, 1912 and 1919 (33 U.S.C. 622 and 624).

3.1.1 Section 401 of the Clean Water Act

This section requires that any applicant for a federal license or permit to conduct an activity including, but not limited to, the construction or operation of facilities, which may result in any discharge into navigable waters, must provide the permitting agency a certification from the responsible state (or interstate agency, if appropriate) that the discharge will be in compliance with appropriate effluent limitations and water quality standards. A mechanism for public notice is required, and public hearings may be held if appropriate. No license or permit can be granted until the certification has been obtained (or waived due to inaction by the state on the request for more than one year). Once the Water Quality Certification has been obtained and the terms of this section of the act complied with, other necessary permits can proceed.

3.1.2 Section 404 of the Clean Water Act

The discharge of pollutants from point sources into the waters of the United States is prohibited by Section 301 of the Clean Water Act, unless the discharge is in compliance with Sections 402 and 404 of the Act. Section 402 establishes the National Pollutant Discharge Elimination System (NPDES) which is administered by the Administrator of the Environmental Protection Agency (EPA). In a similar vein, Section 404 of the Act establishes a permit program, administered by the Secretary of the Army, acting through the Chief of Engineers, to regulate the discharge of dredged or fill material into the waters of the United States.

Applications for Section 404 permits are evaluated using guidelines developed by the Administrator of EPA, in conjunction with the Secretary of the Army (see 40 CFR 230). The Chief of Engineers can make a decision to issue a permit that is inconsistent with those guidelines if the interests of navigation require it. Section 404(c) gives the Administrator, EPA, further authority, subject to certain procedures, to restrict or prohibit the discharge of any dredged or fill material that may cause an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas.

In 1974, the Natural Resources Defense Council and the National Wildlife Federation filed suit against the Secretary of the Army, Corps of Engineers, and the Environmental Protection Agency. The plaintiffs asked the court to compel the Department of the Army to extend its Section 404 jurisdiction to all waters of the United States, the pollution of which could affect interstate commerce. The current Corps of Engineers permit regulations respond to this mandate, the jurisdiction of Section 404 having been extended to all waters subject to use for navigation, recreational use, production of fish and shellfish, production of agricultural products, industrial water supply or any other purpose which involves the use of the waters for interstate or foreign commerce purposes. This extended jurisdiction means that Section 404 now regulates activities in many waters of the United States that were never subject to that particular regulation under the Section 10 permit program (see Section 3.1.3). The Natural Resources Defense Council and the National Wildlife Federation also requested the EPA and the

Corps of Engineers to publish the Section 404(b)(1) guidelines which, although required by statute, had not been published at the time the suit was filed. These "Guidelines for Specification of Disposal Sites for Dredge or Fill Material" were published by the EPA in revised form in December 1980 (45 FR 85344; 40 CFR 230). They became effective in March 1981 and included a testing section. The Testing Requirements for the Specification of Disposal Sites for Dredged or Fill Material have also been published in the Federal Register (44 FR 58082). Unless it can be demonstrated that a discharge will not have an unacceptable adverse impact on the aquatic environment, it is the fundamental precept of these regulations that dredged or fill material should not be discharged into the aquatic ecosystem. One of the most important guiding principles is that the degradation or destruction of areas considered special aquatic sites may represent an irreversible loss of valuable resources. While these regulations are quite complex and highly controversial, they have been in effect only a limited time and apparently did not affect the projects reviewed for this report.

3.1.3 River and Harbor Act of 1899

The River and Harbor Act of 1899 (or the Refuse Act) was enacted to protect navigation and the navigable capacity of the nation's waters. Permitting authorities relevant to dredging activities under the 1899 Act are found in:

- Section 9 which prohibits the construction of any dam or dike across any navigable water in the absence of Congressional consent and Corps approval.
- Section 10 which prohibits the unauthorized obstruction or alteration of any navigable water.

Under Section 10, the construction of any structure in or over any navigable water of the United States, the excavation from or depositing of material in such waters, or the accomplishment of any other work affecting the course, location, condition, or capacity of such waters is unlawful unless the work has been recommended by the Chief of Engineers and authorized by the Secretary of the Army. The instrument of authorization is designated an individual permit, general permit, or letter of permission. The authority of the Secretary of the Army to prevent obstructions to navigation in the navigable waters of the United States was extended to artificial islands and fixed structures located on the outer continental shelf by Section 4(f) of the Outer Continental Shelf Lands Act of 1953, 43 U.S.C. 1333(f).

3.1.4 Section 103 of the Marine Protection, Research and Sanctuaries Act.

The Marine Protection, Research and Sanctuaries Act of 1972 (commonly referred to as the "Ocean Dumping Act") contains provisions that resemble the permitting approach taken by the Clean Water Act. Specifically, Section 103 of the Act is similar to Section 404 of the Clean Water Act in that it creates a separate permit program to be administered by the Secretary of the Army, acting through the Chief of Engineers, for the authorization of the transportation of dredged material in ocean water for the purposes of disposal at designated disposal sites. The Act requires the Corps of Engineers to make the same evaluation that is required of the Administrator for the ocean dumping of other materials, using the ocean dumping criteria developed by the Administrator. The Act also requires the Corps of Engineers to utilize, to the maximum extent feasible, ocean dumping sites that have been designated by the Administrator, EPA.

At the present time (February 1982) the ocean dumping criteria are being revised by EPA, and the new criteria may depart significantly from the current version. These criteria only apply to material that is ocean disposed, and hence do not affect much of the dredging done in the Chesapeake Bay. The Norfolk District is, however, in the process of seeking designation of an ocean disposal site, which would be subject to these criteria.

In addition, ocean dumping proposals are also influenced by the 1972 convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (the London Convention), of which the United States is a signatory. This was accomplished by a 1974 amendment to the Ocean Dumping Act which amended the Administrator of the Environmental Protection Agency's authority to promulgate ocean dumping regulations in order to establish or revise criteria in accordance with the Convention to the extent this could be accomplished without relaxing the requirements of Title 33, Section 1412(a).

3.1.5 Other Federal Legislation

The review of applicable federal permitting authorities summarized above is involved with or related to other federal legislation. These statutes are briefly discussed in the following paragraphs to provide a more complete framework for the Corps general regulatory policies.

Section 307(c) of the Coastal Zone Management Act of 1972 requires federal agencies conducting activities, including development projects, directly affecting a state's coastal zone to comply, to the maximum extent practicable, with an approved state coastal zone management program. It also requires that certification of compliance with the management program be provided by any non-federal applicant for a federal license or permit to conduct an activity affecting land or water uses in the state's coastal zone. Generally no federal permit will be issued until the state has concurred with the non-federal applicant's certification.

The Fish and Wildlife Coordination Act expresses the concern of Congress for the quality of the aquatic environment as it affects the conservation, improvement, and enjoyment of fish and wildlife resources. There is a Memorandum of Understanding between the Secretary of the Interior and the Secretary of the Army, dated July 13, 1967, providing procedures for coordinating the concerns of both agencies (see Appendix B of the Corps of Engineers Final Regulations, dated July 19, 1979).

The National Environmental Policy Act is intended to encourage a productive and enjoyable harmony between man and his environment. Section 102 of that Act directs that "to the fullest extent possible: (1) the policies, regulations, and public laws of the United States shall be interpreted and administered in accordance with the policies set forth in this Act, and (2) all agencies of the Federal Government shall... "insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision making along with economic and technical considerations..." Detailed environmental impact statements are required if a proposed major federal action would significantly affect the quality of the human environment.

There is other federal legislation which may, under certain circumstances, have a bearing on the disposal of dredged material. Foremost among these is the Resource Conservation and Recovery Act (RCRA) of 1976 (PL 94-580, 42 U.S.C. 6901 et seq.). The Act applies to nearly all nonagricultural, solid, and liquid wastes which are not subject to Section 402 permits. A major aspect of the Act is its two-stage regulatory program for hazardous wastes. Under Subtitle C of the Act, EPA established criteria for determining the characteristics of hazardous wastes and established regulations, as may be necessary to protect human health and the environment, applicable to hazardous wastes generators, transporters, and owners and operators of treatment, storage, and disposal facilities. Section 6004 of RCRA requires that federal agencies which generate solid wastes or which permit waste disposal must ensure compliance with the Act. Accordingly, land disposal of dredged material would be subject to RCRA. Should this material be classified as "hazardous wastes," it would further be subject to the comprehensive Subtitle C regulatory program.

Under Section 142(e) of the Safe Drinking Water Act, the Administrator, EPA, may identify certain drinking water aquifers, the pollution of which would create a significant hazard to public health. Upland disposal of dredged material could be restricted if it was done in the vicinity of designated aquifers. No such aquifers are, as yet, designated in the Chesapeake Bay region.

In addition to the impact of these laws and regulations directly affecting dredging and dredged material disposal, the acquisition of foreign built dredges is regulated under the Jones Act. This act, originally designed to protect the U.S. shipbuilding industry, has proven difficult to interpret. It does, however, state that:

> "A foreign-built dredge shall not, under penalty of forfeiture, engage in dredging in the U.S. unless documented as a vessel of the United States" (46 C.F.R. 292).

According to Hoffman (1978a), based on interviews with foreign dredging firms, it is not possible to obtain documentation as a U.S. vessel for dredging equipment. The Act (Article 46) further restricts the importation of a foreign vessel by limiting the traffic of vessels between points in the United States to vessels built and documented under the laws of the United States. Waivers can be obtained in special cases, but with great difficulty. This opinion was confirmed by Scholle (1981), who noted that the prohibition could be waived by the U.S. Customs Service in specific cases where deemed necessary in the interest of national defense by the Secretary of Defense. According to Hoffman (1978a) dredging in the U.S. could be improved by the acquisition of European equipment not available on the American market. He gives the example of bucket dredges, which are useful in dredging slips and would be too expensive to build in the U.S. because of the tooling up procedure and the relatively limited market. He also points out that there are second hand bucket dredges in Europe available for purchase by American dredging firms if it were permitted. The Japanese Oozer dredge, which could be particularly valuable in dredging polluted sediments, is similarly affected.

Public Law 95-269 encourages the Corps of Engineers to utilize contractor equipment when industry demonstrates its capability to perform the work at reasonable prices and in a timely manner. It also recommends that the Corps of Engineers reduce its dredging fleet to the minimum required to perform emergency and national defense work. As long as contractor's bids do not exceed 25% of the estimated cost of doing the work with the Corps plant, the dredging work should be performed by a contractor. The Corps of Engineers is expected under this law to successively retire its older vessels and retain only a minimum but technologically modern fleet of dredges. As a result, the Industry Capability Program was initiated by the Corps of Engineers in 1976 with the issuance of Corps of Engineers Circular EC 1125-2-358. The program gave industry the opportunity to bid competitively with the Corps of Engineers over various dredging projects. By the end of August 1979 statistics showed that the Industry Capability program had totalled a saving of 16.1 million dollars to the taxpayers (Murden, 1980). The industry has risen to the opportunity provided by this program by acquiring new dredging units to increase their efficiency. One can expect that the industry performance will continue to improve since some of its newest equipment is still under construction.

The remaining federal legislation which may have a bearing on dredged material disposal includes:

- The Endangered Species Act of 1973 as amended (16 U.S.C. 1531 et seq.) which states inter alia that federal agencies ensure that their actions do not jeopardize the continued existance of endangered or threatened species or result in the destruction of critical habitat.
- The National Historic Preservation Act of 1966, as amended (16 U.S.C. 470 et seq.), which requires that agencies consider potential impacts on significant historical or archaeological resources.
- Section 302 of the Ocean Dumping Act which authorizes the Secretary of Commerce to issue regulations to control activities within areas of the ocean waters (including estuaries) or Great Lakes which have been designated as marine sancturaies.

3.1.6 Federal Implementing Regulations

The principal agencies having regulatory or criteria setting functions in the above legislation are the U.S. Army Corps of Engineers and the Environmental Protection Agency. Corps of Engineers regulations regarding the transport and disposal of dredged material are contained in 33 CFR 320-329. These regulations apply to both federal and non-federal projects and require consideration of all issues raised by the legislation discussed above. Where appropriate they refer to additional regulations, such as the EPA Ocean Dumping Criteria or Section 404 Criteria, which require compliance. Under most circumstances adherence to these regulations is not difficult. On occasion, however, special circumstances may lead to involvement with several additional sets of regulations, such as those for hazardous waste management, wastewater discharges, or groundwater protection. These issues generally arise with respect to disposal options rather than the dredging project itself. In such cases compliance becomes considerably more complex. Non-federal applicants generally must rely on the staff of the Corps of Engineers to inform them of any additional regulations to be consulted, which should occur as soon as possible after the initial permit application.

The federal legislation and regulations reviewed previously call for compliance with substantive state, interstate, and local water quality standards and effluent limitations. Non-federal applicants are required to show proof of compliance with local and state regulations before the Corps will issue a Section 404 permit.

3.2 State of Maryland Legistation and Regulations

While states may, under the Clean Water Act of 1977 (33 U.S.C. 1251 et seq.), elect to administer their own permit programs for the discharge of dredge or fill material into non-tidal navigable waters, Maryland has not done so. There are, however, numerous Maryland laws which must be considered during the permit process. Those most relevant to dredging and dredged material disposal are the Solid and Hazardous Waste Law, the Water Resources Law, and Water Pollution Control Regulations. The primary state agencies tasked with enforcement of the state laws and regulations are the Department of Natural Resources and the Department of Health and Mental Hygiene. Maryland also has a federally approved coastal zone managment plan, administered by the Tidewater Administration, part of the Department of Natural Resources.

3.3 Commonwealth of Virginia Legislation and Regulations

As was true in Maryland, Virginia has not as yet opted to expand its authority with respect to administration of Section 404 permits. The Commonwealth does not have a federally approved coastal zone managment plan, although a wide range of protective legislation has been inacted. Laws and regulations relevant to the issues of dredging and dredged material disposal include the Solid and Hazardous Waste Management Law and the implementing Solid Waste Regulations, and the State Water Control Law and implementing Regulations and Standards. Responsible state agencies are the Virginia Marine Resources Commission, the State Water Control Board, and the State Health Department.

3.4 Permit Processing Procedures

Many of the environmental laws and regulations just described were enacted or strengthened within the last ten to fifteen years. As a result, both federal and state regulatory requirements have increased. The reconciliation of often conflicting demands and requirements, as well as the time-delays and expense involved, has become a major concern, especially because of the number of regulatory agencies involved. This has been an issue in both the Norfolk and Baltimore Districts for a number of years, since it was reflected in delays in the permitting process. Both offices have taken steps to improve the situation.

In the Norfolk District, joint permit processing sessions have been held monthly since August 1976. These meetings include representatives of the Corps, EPA, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and, on the state level, the Virginia Marine Resource Commission, the State Water Control Board, the Virginia Institute of Marine Science, and the Bureau of Shellfish and Sanitation of the State Health Department (Larsen, 1980). The purpose of these meetings is to expedite the processing of applications, and to ensure the direct exchange of opinions between responsible agencies. A joint permit application combining federal and state requirements in one form has been in use in the Norfolk District since April 1978, and has further increased the processing efficiency.

In the Baltimore District a joint permit review committee also meets once a month. It is composed of the federal agencies listed earlier and, as representatives of the State of Maryland, the Maryland Port Administration, the Board of Public Works, the Department of Natural Resources and the Department of Health and Mental Hygiene. The Maryland Port Administration and Board of Public Works representatives do not normally attend meetings, rather they provide input through the water quality certification process, administered by the Maryland Department of Health and Mental Hygiene and the Wetlands Licensing Program of the Maryland Department of Natural Resources. For projects in Maryland, the district is working on a joint permit application which would include all federal and state requirements. At this time, however, it is still necessary for a Maryland applicant to obtain, besides the Corps dredging permit, a wetland license issued by the Maryland Department of Natural Resources, which includes a water quality certificate issued by the Department of Health and Mental Hygiene (Durkay, 1981). For those projects in Virginia (a portion of the Potomac River Basin) a joint application form is currently in use.

4.0 IMPACT OF CURRENT DREDGING PRACTICES

The main impetus for the preparation of this report was the impression, by a wide range of agencies and individuals, that controversies over ongoing or proposed dredging projects in the Chesapeake Bay had reached the point where a critical evaluation of procedures and problems throughout the Bay was in order. It was hoped that such an evaluation would lead to improvements in the procedures or equipment now in use, which, in turn, would lessen the controversy associated with dredging projects. Of course, the term "improvement" could have a wide range of meanings in such a situation, but we have defined it as "less environmentally damaging with no unacceptable increase in cost." This definition, as do most, contains an element of ambiguity. We do not propose any specific definition of unacceptable, since that will obviously depend on the viewpoint of the evaluator. In this report we will attempt only to indicate the extent of probable economic impacts. One essential element in this evaluation is a determination of the extent of the impacts caused by existing procedures. In this section we address this issue from four perspectives:

- perceived environmental issues
- probable or documented environmental impacts
- regulatory controls
- economic costs.

Each of these factors has a role to play in the evaluation of new approaches.

4.1 Perceived Environmental Issues

Any attempt to prepare a comprehensive list of environmental concerns associated with dredging is probably doomed to failure by the diversity of opinions; however, our research during this project suggests that the following issues occur repeatedly in evaluations of projects in the bay (not listed in order of significance):

- impact of turbidity on fish and wildlife, especially shellfish,
- release of toxic substances,
- loss of valuable habitat, especialy wetlands,
- decline in water quality,

- aesthetics, and
- risks to human health.

All of these are legitimate concerns, but much of the controversy and discussion appears to be based on extrapolation to a "worst case" situation, or on very limited data. In other cases, regulatory programs which are already in place appear adequate to protect the environment. The available information on the environmental impact of current procedures is summarized in the following section.

4.2 Probable or Documented Environmental Impacts in the Aquatic Environment

Impacts of dredging activities are primarily associated with the actual dredging operation or with placement of the material at a disposal site. Transportation of the material is usually not a significant concern. In addition, all evidence suggests that, of the two operations, disposal is by far the most controversial as well as the most likely to cause adverse impacts. While this report is focused primarily on dredging operations, some discussion of open water disposal impact is included as well because of the critical issues involved. Impacts associated with upland disposal options are not included.

4.2.1 Physical Impacts

Dredging and open water disposal activities can both result in three major direct physical impacts to the estuarine environment. These are:

- changes in submarine topography due to removal (dredging) or deposition (disposal) of material,
- increases in concentrations of suspended particulates, and
- alteration of existing sediment type.

Any or all of these may be of concern in the local operation area, especially if a sensitive resource, such as shellfish beds or fish spawning sites are present. On the other hand, our ability to predict the physical impacts of dredging or disposal is much further advanced than our capabilities to predict chemical effects. Given a knowledge of local conditions, changes in bottom topography and sediment plume distribution can be modeled quite accurately through any number of operational mathematical models; while simple physical testing can determine sediment compatability. Of the three, turbidity is probably of the greatest concern, and its ecological impacts are discussed in Section 4.2.3.

Changes in submarine topography, either from dredging or disposal, can cause changes in the hydrographic regime of the bay and eliminate or create habitat for various estuarine organisms. For example, fish wintering habitat in deep troughs, where the water is warmer, could be eliminated if material were to be deposited in such locations, or shallow water nursery areas can become less suitable if a channel is dredged through them. There are any number of examples such as this; however, such hydrographic changes, while they have the potential to be significant, can be reasonably predicted prior to the event, either through the use of mathematical models or the physical model of the Chesapeake Bay recently constructed by the U.S. Army Corps of Engineers. Only modifications to the major federal projects are likely to be of concern. The approach channels to Baltimore Harbor may be of particular interest, due the unusual three-layer circulation pattern which exists in the harbor. This pattern appears to be the result of the presence of the dredged navigation channel (Schubel et al., 1980), and its alteration would need careful consideration.

Increases in turbidity caused by dredging and/or open water disposal are often mentioned with respect to potential biological impacts, which are discussed in Section 4.2.3. It is obvious that both activities will effect turbidity. The level of suspended sediment which will occur is dependent upon the type of equipement used and can be reduced but not eliminated. Hydraulic dredging and pipeline disposal result in the continuous generation of suspended material, producing a plume of material extending away from the site in the direction of the current. This is the most common type of dredging and disposal activity in the main federal channels of the bay. Open water disposal using barges or hopper dredges results in a series of discrete releases of material at the disposal site.

In either case, physical impacts appear to be minimal and restricted in their extent. According to Schubel and Meade (1977), increases in total suspended solids of more than 100 mg/l are generally localized, within a few 100 meters of the activity. Even these levels are with in the range of values which occur naturally in the upper Chesapeake Bay (Schubel et al., 1980). During periods of high flow, total suspended solids values at the mouth of the Susquehanna River may be as high as 140 mg/l, dropping to about 20 mg/l opposite the mouth of Baltimore Harbor and to 10 mg/l or less by mid-bay (Schubel et al., 1980). In addition, tidal currents can cause bottom resuspension. This is especially true in the upper bay where total suspended solids values 0.5 meters above the bottom may range from 15 to 300 mg/l (Schubel et al., 1980).

The natural occurrence of high levels of turbidity is seasonal, occuring mainly in the spring. However, recent studies have shown the bay to be even more dominated by individual events than was previously suspected. In a "typical" year the estuary is estimated to receive approximately 0.6 to one million metric tons of sediment. In comparison, in one week in June 1972, after tropical storm Agnes, the bay received 34 million metric tons of sediment, and in one week in September 1975, after Hurricane Eloise, ten million metric tons of sediment entered the bay.

Bottom sediment type alterations are usually mentioned in discussions of open water disposal operations, but may also occur in dredged channels if the dredging exposes a different type of substrate. This is uncommon, but it can occur. If it does, natural sedimentation will restore the previous condition. The impact at a disposal site can be much longer lasting. If dredged material is placed in an area where the substrate is different from that at the dredging site, extensive physical modification may occur, especially if the material is subject to redistribution by currents. An excellent example of this occurs at the dredged material ocean dump site for New York Harbor. In that area the natural bottom is primarily coarse to fine sand, while the dredged material is primarily silt. This has resulted in a major physical modification in the vicinity of the disposal site (Conner et al., 1979).

Mounding at a disposal site is primarily a factor of the amount material to be disposed, its method of placement, and the local current regime and turbidity. The creation of areas which are sufficiently higher then natural bottom can occur at heavily used disposal sites, and may then affect the biota or the hydrographic pattern.

4.2.2 Chemical Impacts

Dredging or disposal of dredged material in an estuarine environment causes adverse chemical impacts if: 1) the disposed material is contaminated with hazardous or undesirable substances, and 2) harmful amounts of sediment-bound contaminants are released and become available for biological uptake or chemical reactions in the water column, or are biologically available to benthic organisms in direct contact with the sediments.

There is only a limited amount of historical data on sediment composition in areas of the bay which are regularly dredged. Some information is available for the Baltimore Harbor area, where the sediments are known to be contaminated with a variety of toxic substances, including heavy metals and synthetic organic compounds.

While such materials seem to be most prevalent in the sediments of the marginal creeks of the harbor, they are present throughout the area (Schubel et al., 1980). Data on other bay tributaries are much more limited, with the exception of the Kepone studies of the James River and an on going evaluation of Norfolk Harbor sponsored by the Norfolk District (Alden, undated).

The Norfolk District, as part of its program to have an ocean disposal site approved for future use, has embarked on a series of extensive field and laboratory studies to aid in the evaluation of potential biological impacts at the proposed site. This study, still in process (February 1982), involves bioassay, bioaccumulation, microcosm and field experiments. The most recent results have been summarized by Alden (undated). There appears to be a two to four mile stretch in the Southern Branch of the Elizabeth River where sediments demonstrate significant lethal and sublethal effects, based on short term bioassay tests and respiration measurements using the grass shrimp *Palaeomonetes pugio*. In addition, microcosm studies suggest the possibility of short-term changes in water quality and possibly the zooplankton community at the disposal site if such material is released; however, these would probably be localized impacts. Sediments taken from other stations in the harbor were found to be relatively non-toxic. While this study provides data for the main channels under the jurisdiction of the Corps, it does not provide data on the more inshore areas, which might be expected to be more contaminated, based on the Baltimore data.

Chemical testing is not normally required by either the Norfolk or Baltimore District prior to dredging or disposal unless a 401 or 404 permit is required and there is reason to suspect contamination. No bioassay testing has been required. The state of Maryland requires bulk analysis testing of the material and the sediment at the disposal site (open water) to check for compatibility and to check for compliance with the state criteria for overboard disposal. It appears to be the general consensus of the regulatory agencies that severe pollution problems are restricted to limited areas of the Baltimore and Norfolk Harbors, and possibly certain other sites, but that the majority of the dredging in the bay occurs in relatively unpolluted sediments. This is a logical conclusion given the distribution of point sources for pollutants, and/or the concentration of potential nonpoint sources.

As far as chemical availability is concerned, the literature suggests that no significant short-term water quality variations should be expected, either from dredging or disposal operations

(Hirsch et al., 1978). This conclusion is supported by both field observations and laboratory studies, which show minimal release of contaminants, followed by rapid dilution.

There is less certainty concerning the long-term availability of contaminants in dredged material after placement at an open water disposal site. Two types of long-term chemical impacts may result from the disposal of contaminated material. First, there is the possiblity of gradual release of contaminants into the overlaying water column. While it is true that, on the basis of chemical equilibria, release via diffusion through the deposited sediment is possible under some conditions, no evidence of such release has ever been reported in field studies. Considering the effect of dilution and the relatively slow rate of diffusion which would occur, it is unlikely that this process would be significant. This assumes that the material remains undisturbed. Resuspension would change the existing chemical environment, particularly with regard to oxidation-reduction potential, and hence could influence chemical equilibria. While disposal at a site where resuspension is unlikely is highly preferable, the resuspended sediments, would, in most respects, be analagous to recently dumped, or discharged, material. In this case the data summarized by Hirsch et al. (1978) would suggest minimal release and rapid dilution.

The second type of long-term chemical impact involves the accumulation of foreign, contaminated material at the disposal site. The concern in this case is that organisms in contact with the sediment may be affected. This possiblity is a significant issue with respect to dredging Baltimore Harbor and the James River, where contaminated sediments are known to exist. Unfortunately, this is the least understood issue with respect to disposal. The closest thing to a standard procedure for its evaluation is the bioassay procedure used in the ocean dumping criteria. While these tests may adequately evaluate short-term impacts, they do not address long-term exposure or sublethal impacts. Bioassay tests have been used to characterize Baltimore Harbor sediments (Tsai et al. 1979), but only fish were used. In these tests sediments of the Inner Harbor were rated moderately toxic, with highly toxic sediment in the marginal creeks. Except for the Norfolk study already described, there is little information available on conditions in other parts of the bay.

4.2.3 Biological Impacts

While a wide range of biological impacts has been postulated for dredging in the bay, there is no documentry evidence of any significant adverse impacts directly related to dredging to date.

(A review comment by the Maryland Tidewater Administration suggested strong disagreement with this statement; however, no data were provided for inclusion. They did correctly point out that the use of the term significant here may be misleading, since it cannot be accurately defined.) The most extensive study currently available is the biological testing now being done for the Corps of Engineers in Norfolk Harbor (Alden undated), which was summarized in Section 4.2.2. That study clearly indicates that a limited reach (two to four miles) of the Southern Branch of the Elizabeth River is contaminated with toxic substances. Disposal of these sediments in open water would result in adverse impacts, the exact extent of which would depend on the disposal option. The rest of the stations tested appear to have little or no biological activity. It appears to be a relatively accepted assumption that most of the sediments in the bay are uncontaminated, but that certain areas, mostly in the highly industrialized inner harbor areas, may contain pollutants. The data which are available support this assumption, although there are no data on relative volumes of material dredged in each type of situation. The literature summarized by Hirsch et al. (1978) indicates that dredging and disposal of uncontaminated material has only localized and transitory impacts in most ecosystems. Two major sources of concern with uncontaminated material, nutrient release and oxygen depletion, repeatedly have been shown to be minimal.

A third major issue, turbidity, appears to be of concern only in special cases involving an ecosystem with unusually high sensitivity. Two possible examples are coral reefs or sea grass beds. Studies by Schubel et al. (1980) for projects in the Chesapeake Bay suggest that elevated turbidity levels would exist only in the immediate vicinity of the operation. Locally high levels may, however, be important during a period of normally low turbidity in sensitive reqions of the bay. It is frequently suggested that invertebrate and vertebrate larval or immature stages may be adversely affected by turbidity when dredging occurs in the vicinity of spawning or nursery grounds in the upper bay. While this concern is widely held and is supported by evidence for some species (Stern and Stickle, 1978), it is equally clear that the areal and temporal extent of such potential impacts in the Chesapeake Bay would be very limited. Most of the species likely to be present in estuaries must be normally adapted to relatively high levels of turbidity. Representative species of several groups of animals, including larval fish, likely to be present in the Chesapeake Bay have been shown to be able to withstand exposure to levels of uncontaminated suspended sediment much higher than those likely to occur even at the dredging or disposal site (Schubel et al., 1980; Peddicord and McFarland, 1978).

In their comments on the draft report, the Tidewater Administration of the Maryland Department of Natural Resources indicated that they had reservations concerning our conclusions on the significance of localized impacts of dredging and disposal of uncontaminated material. They wrote:

> Localized and transitory impacts can be very significant when the resource is localized, such as shellfish beds, and localized and time limited, such as seasonal finfish and shellfish spawning. Localized watermen utilize localized resources which are locally critical. Declaring dredging impacts to be localized and transitory is further misleading because projects occur virtually throughout the Bay system and during the whole year except where time restrictions are applicable.
>
> Of course there are no in situ studies which definitevely indicate that dredge operations are solely responsible for large scale environmental degradation. Neither is there definitive evidence that single causes are totally responsible for declines in abundance of the highly studied striped bass and submerged aquatic vegetation. It is impossible to examine almost anything in the natural Bay setting without having confounding variables that obscure the picture. This is why we must rely upon laboratory studies as indicators of effect, and they do indicate deleterious effects from dredging.

It is our opinion that these arguments have often been extended beyond reasonable limits in dealing with the evaluation of impacts. In the extreme, the comments could be used to advocate no dredging at all, which is clearly impossible. While local impacts need be considered, conclusions as to their significance must relate to the total resource and the incremental effect the proposed action will cause. The impact of the dredging operation must also be viewed against the existing conditions that will prevail during the operation. If, for example, it can be demonstrated that the increase in turbidity in a particular dredging operation will be essentially unnoticable beyond the project boundaries, and no sensitive resources occur within that zone, then a project should not be evaluated on a worst-case basis.

Both dredging and disposal have been shown repeatedly to result in the destruction of the local resident benthic community. Recovery appears to be rapid, however, and is usually complete within one or two years (Schubel et al., 1980; Diaz and Boesch, 1977). After the destruction of the resident population, recolonization begins from adjacent areas, both by larval recruitment and lateral migration of adults if the sediment type is compatible. Generally, opportunistic species dominate early recovery and then a population similar to that in surrounding areas develops. This sequence is, of course, controlled by the type of sediment involved, and the deposition of incompatible material can cause major changes in the community (Hirsch et al., 1978). Any proposal which allows this to occur should be carefully evaluated, since it could result in permanent changes to populations of other species dependent on the affected benthic fauna. The dredged material itself may contain organisms which survive (especially in mechanical dredging) and become the main source of recolonization. In addition, the continuous disposal of material at one site over a period of years may prevent the recovery of the site and result in an inpoverished fauna or a high concentration of opportunistic species, depending on the rate of deposition.

The potential impacts associated with the disposal of contaminated sediment are much more serious, and, although literature currently available does not indicate any problems at existing disposal sites in the Chesapeake Bay, there is reason for caution. Materials which are known to be present in the sediment of Baltimore Harbor are also known to be biologically active and are of concern.

The presence of contaminated sediment does not necessarily mean that significant adverse biological impacts would result. For contaminants (e.g., metals, chlorinated hydrocarbons, petroleum hydrocarbons) to cause detrimental effects, they must be available for biological uptake, which can occur through direct ingestion or absorption through the skin and/or gill membranes (Mullins, 1977). Contaminants may then be retained in the organism or eliminated through excretion, defecation or simple diffusion. Both field and laboratory evidence indicates that large-scale contaminant release and concentration in benthic invertebrates is sporadic, highly variable and not common (Neff et al., 1978). However, many of the contaminants found in dredged material can have important effects even in relatively small amounts and low concentrations. Long-term sublethal effects, such as changes in reproductive ability, behavior or development are particularly important but remain poorly analyzed.

If exposure and availability are assumed, then bioaccumulation and biomagnification are potential problems. Bioaccumulation occurs when a single organism concentrates a contaminant above ambient levels. Biomagnification refers to the progressive concentration of a contaminant through several levels of the food chain. Accumulation of a known toxicant in a human food source is obviously serious. Accumulation of a toxicant in estuarine or marine systems may result in sublethal effects or mortality. As far as is known, biomagnification occurs only with DDT and related organohalogens, mercury and mercury compounds, and polychlorinated biphenyls.

At the present time, the only tool for evaluating potential biological impacts is the bioassay test. While this approach is certainly not perfect, it is far superior to the bulk analyses and elutriate testing it has superseded. Neither bioassay testing or monitoring of test organisms at disposal sites are conducted on any organized basis in the Chesapeake Bay. There are, however, no reports of impacts directly attributable to dredging or disposal.

4.2.4 Public Health Impacts

No data were found which would directly relate to public health. In other areas of the country, issues raised have included:

- contamination of fish or shellfish used for human consumption, and
- bacterial contamination of public beaches.

Neither of these issues appear to be a significant concern for dredging projects in the Chesapeake Bay. In any case, the possible sources of contamination for either are so diverse that a cause and effect relationship would be difficult to verify. In those cases which have occurred in the past, dredging and dredged material disposal have not been implicated.

4.3 Possible Impacts of Terrestrial or Confined Disposal of Dredged Material

While this report is mainly concerned with the aquatic environment, the review of dredging records for the two Corps districts indicated a strong tendency towards increasing use of terrestrial or confined disposal options. This is particularly evident with respect to private dredging permits in both districts. In the Norfolk District the use of the Craney Island disposal site for large projects in both the federal and private sector is a major factor in disposal planning, and it is assumed that Hart and Miller Island will be equally significant, at least for federal projects, in the Baltimore District.

Without preparing a detailed discussion of the ecological impacts of terrestrial or confined disposal, it is worth noting that they are not a cure-all for the disposal of contaminated sediments. Indeed, in some cases, the use of such an option may increase the potential for estuarine impacts, as well as open the possibility of terrestrial and freshwater contamination. Leachate and effluent must be carefully monitored and controlled in such systems, if used for contaminated materials. Site acquisition for use is almost always a major social issue, and public health questions are also likely. As far as unpolluted sediments are concerned, these options offer different, but, once again, largely localized impacts. This is true as long as the level of suspended solids (and salt if placing estuarine sediments near fresh water) in the effluent is maintained at a proper level.

4.4 Regulatory Controls

Regulatory controls on both dredging and dredged material disposal have increased significantly in the past decade. While this certainly resulted in permitting delays initially, both Corps districts have undertaken programs, in conjunction with other concerned federal and state agencies, to improve the permit review process. Their efforts to develop a consolidated, one-step review process appear, at least from the standpoint of the regulatory agencies, to have been largely successful. Both districts indicated that further improvements are anticipated.

The major exception to this would appear to be large projects where there is a significant controversy over contamination levels in the sediments. Projects of this type would still require several years for approval. If a private project were involved, the applicant would probably find the normal procedures inadequate to ensure the timely processing of his application.

Restrictions may be placed on dredgers with respect to turbidity levels, the time of year dredging will be permitted, and the type of disposal which will be allowed. In the case of confined or upland disposal, the dredger must comply with effluent standards and receive a discharge permit. Additional types of restrictions could, theoretically, be developed in specific cases. Again, these issues appear to occur mainly (if not entirely) in the case of large projects.

4.5 Economic Costs

Dredging company spokesmen interviewed for this report were almost unanimous in their assertion that environmental controls have greatly increased the costs associated with dredging. Increases as high as fivefold were offered as being realistic in some cases. Specifically mentioned as causes were restrictions in the time of year dredging is allowed and the cost of transportation to upland disposal sites, particularly for small projects.

These contentions cannot be evaluated for private projects, since cost data for those projects were not evaluated, but they do not appear to be strongly supported by the average annual costs for federal projects shown in Tables 2-4 and 2-5, and Figure 2-5. Inflation alone, assuming an average annual rate of increase of ten percent for the entire period, is sufficient to account for most of the increase. The rest appears to be a factor of normal variability in costs. This variability is even more evident if the raw cost data in Tables A-1 through A-22 are examined. Project costs are highly variable, and the attribution of a major cost increase to one specific factor is very difficult to prove or disprove. Circumstantially, the case for increased cost is strong where upland disposal has been used for small projects, since it is usually more expensive. In the case of federal projects, even though upland disposal is becoming much more prevalent (see Section 2.4), the large volumes involved appear to mask any cost increases. If there has been a major cost increase due to compliance with environmental regulations, it appears to have fallen on the private sector, where it could not be readily evaluated.

5.0 IDENTIFICATION AND DESCRIPTION OF AVAILABLE TECHNOLOGIES

Many different kinds of dredges are currenty available. Choosing the right dredge for a particular dredging project can be a difficult task involving the consideration of:

- the nature of the sediment to be dredged,
- location (harbor, estuary or riverbed),
- site depth,
- quantity of sediment to be dredged,
- environmental conditions and consequences,
- existing dredging practices,
- cost of the chosen dredging unit, and
- availability of the particular dredge.

Innovative technologies, in particular, must be considered carefully, since fewer records are available on their performance and their acquisition represents a very large investment. The information in this section was compiled from the open literature, as well as from manufacturers' brochures. The use of manufacturer's data does not imply endorsement of a particular product and are used only for clarity of discussion. Product information was selected for inclusion based on its current or apparent future value in the Chesapeake Bay. The diversity of dredging and dredging-related equipment now available precluded any more detailed discussion of individual items. Where possible, the following information is provided for each technology:

- type and technical specifications,
- the particular purpose for the equipment,
- the cost and availability of the unit, and
- impact on the environment.

There are three basic types of dredges: mechanical, hydraulic and pneumatic. The relevant equipment in each is discussed below, followed by a brief discussion of selected support technologies.

5.1 Mechanical Dredges

Mechanical dredges operate by means of buckets or scoops of various designs that are lowered and raised either by cables or by articulated arms. The dredged material is deposited on adjacent barges or "on board" in large hoppers (U.S. Environmental Protection Agency (EPA)/Corps of Engineers (COE), 1978). The family of mechanical dredges includes:

- clamshell or grab bucket,
- dragline,
- dipper,
- bucket ladder, and
- backhoe.

General characteristics of mechanical dredges are summarized in Table 5-1.

5.1.1 Clamshell or Grab Bucket Dredges

A dredging unit is called a clamshell when there are two halves to the bucket (Figure 5-1). It belongs to the category of wireline dredges because the bucket is lowered and raised by cables. The dredge can be either self propelled with hoppers, in which case the dredged material is released "onboard" into these hoppers, or it can be mounted on a pontoon with barges alongside to receive the dredged material (Cooper, 1975). This latter option is preferred on the newer grab bucket dredges, so that the dredging operation does not have to be interrupted as often as it used to be. The unit, depending on its size, can be equipped with up to four cranes (d'Angremond et al., 1978). Using its own mass and velocity built up during descent, the bucket "bites" into the sediments and closes through a cable reefing mechanism (COE, 1979a). The bucket is then pulled to the surface, raised above the barge or the hopper and the dredged material is released. The operation is repeated until the barge or the hopper are full. Clamshell bucket capacities range from one to 22 cubic yards. The size of the bucket is chosen according to the job to be performed, and the production rate varies greatly with the nature of the sediment to be dredged. A bucket with a five-cubic-yard capacity attains a production rate of about 3,600 cubic yards per 24-hour day, or 150 cubic yards per hour, not considering downtime. The Great Lakes Dredge and Dock Company,

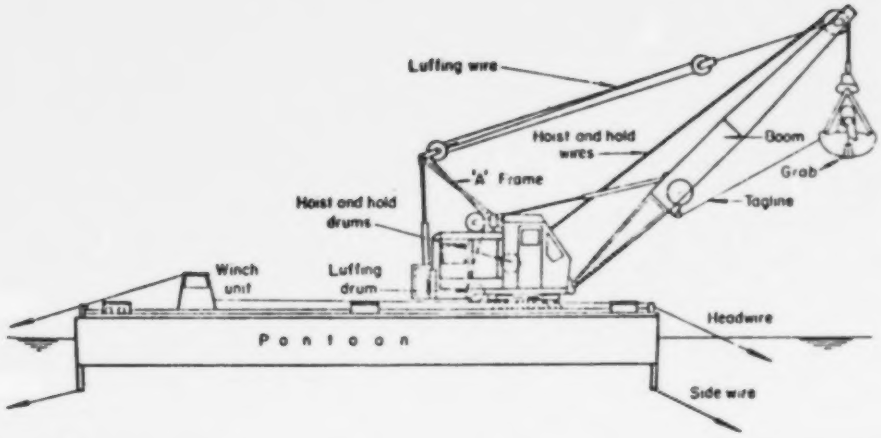
TABLE 5-1

GENERAL CHARACTERISTICS OF MECHANICAL DREDGES

Name (Type)	Best Suited For	Production Rate	Disposal	Availability	Environmental **Impacts and** General Drawbacks	Cost of[1] Operation ($/per cubic yard)	Maximum Dredging Depth (Feet)
Clamshell	soft sedimentary rocks, marine debris, anything but fine silts, stiff clays and rocks	5 yd^3 bucket: 150 yd^3/hr.	self propelled hoppers or receiving barge	available	some turbidity	ranges from $1.25-$8 depending on disposal site	66
Dragline	anything but fine silts, stiff clays and rocks	5 yd^3 bucket: 125 yd^3/hr.	dumps into receiving barge	available	some turbidity requires very strong spuds to retain its balance	variable average $2.95	66
Dipper Dredge	pretreated rock, all kinds of soils but very fine silts	average: 100 yd^3/hr.	dumps into a receiving barge	available	some turbidity	variable average $2.50	60
Bucket Ladder	any soil and rock of sedimentary type. Not good on sticky clays, large boulders and very fine silts	up to 1830 yd.^{3}/hr.	conveyor and barge	not available in the U.S.	much turbidity	not available	98
Backhoe	any kind of soil	average: 100 yd.^{3}/hr.	receiving barge	available	some	variable average $2.50	

[1] These figures only give an indication of operational cost. Prices are highly variable according to the nature of the work, the distance between the dredging project and the disposal site, and the method used for disposal.

Source: U.S. Army Corps of Engineers 1978
U.S. Army Corps of Engineers 1979a
Holland, R. 1981.


Luffing wire
Hoist and hold wires
Boom
'A' Frame
Grab
Hoist and hold drums
Tagline
Winch unit
Luffing drum
Headwire
Pontoon
Side wire

Source: Redrawn after Bray 1979

FIGURE 5-1
CLAMSHELL DREDGE

which is presently working on a dredging project in the Chesapeake Bay at Tolchester and Swann Point, using a 21-cubic-yard capacity clamshell bucket dredge, achieves a production rate of 12,000 to 16,000 cubic yards per day, or 500 to 550 cubic yards per hour (down time not included) (Holland, 1981). The family of bucket dredges built by the C.F. Bean Corporation listed below are all of the clamshell type and, with a bucket capacity ranging from six to eight cubic yards, attain an average production rate of 8000 cubic yards per 24 hour day or 333 cubic yards per hour.

Dredge	Barge Size (Feet)	Bucket Capacity (Cubic Yards)	Boom Length (Feet)
C.F. Bean	130x39x7	6-1/2	120
M.H. Bean	130x39x7	6-1/2	120
Bean No. 4	140x38x7	6-1/2	120
Bean No. 5	130x38x7	6	120
C.W. Bean	155x39x8	8	120
S.B. Whittington	145x39x8	6-1/2	120

Multi-grab dredges, such as the "Abervon" owned by the British Transport Docks Board, are equipped with several buckets on the same vessel (Powers, 1980).

Grab dredges are most suited for dredging marine debris and, according to the size and the design of the bucket, can dredge anything but very fine silt, very stiff clay, or rock. Clamshell dredges are efficient for cleaning up small areas (maintenance work) or for use in conjunction with another type of dredge (d'Angremond et al., 1978). The dredges which are equipped with their own hoppers can function in relatively rough water conditions. New grab dredges have hydraulically assisted bucket closures and are capable of exerting much higher downthrust, making the units more efficent in digging harder materials. Bucket dredges are very practical when clearing access channels or digging trenches for pipeline installation and are therefore very popular and widely used. Bucket manufacturers are numerous (Powers, 1980).

The 21-cubic-yard capacity clamshell dredge owned by the Great Lakes Dredge and Dock Company that is presently operating in the Baltimore Harbor has an average cost of $3.55 per cubic yard. It is obvious that the cost of operation of any dredging unit can vary greatly with the nature of the sediment to be dredged, the distance between the dredging project and the disposal site, and the required method of disposal. Locally, the operating cost range for clamshell dredges is estimated at 1.25 to eight dollars per cubic yard. Buckets are easily obtained and dredging companies usually assemble their own clamshell dredges, changing the size of the bucket according to their needs (Holland, 1981).

The clamshell dredge presents drawbacks from an environmental point of view. Not only does the bucket disturb the seabed when it takes a "bite" of sediments, but a lot of the finer particles escape from the bucket and remain in suspension in the water creating a significant turbidity problem. Better closure of the bucket alleviates this problem, so that modern clamshell dredges are a considerable improvement over earlier equipment.

5.1.2 Dragline Dredges

The dragline dredge operates on the same principle as the clam shell dredge (Figure 5-1). In this case, the bucket is replaced by a metal scoop, hanging from a crane which is mounted either on a barge or on a truck. The scoop, after being thrown away from the hull by cables, falls into the material to be dredged, is dragged back towards the crane (thereby slicing away a chunk of sediments), is closed, raised, and the material dumped into the receiving barge by tipping the bucket (EPA/COE, 1978). A dragline dredge with a capacity of five cubic yards can dredge up to 3000 cubic yards of material in a 24-hour work day, or 125 cubic yards per hour.

The dragline performs best in soft underwater deposits, but can operate in any kind of sediments except stiff clays and rocks (Cooper 1975; Bray, 1977). Because it requires very strong spuds (movable posts) to maintain its balance, it is often considered impractical and is therefore less popular than the clamshell.

A dragline bucket with a five-cubic-yard capacity has been estimated to operate at a cost of about three dollars per cubic yard (COE, 1979a), but this figure will vary greatly with the nature of the work and the proximity of the disposal site. Many manufacturers specialize in the construction of dragline dredges.

As the scoop of the dredge is dragged on the seabed, it resuspends particles, especially if the material to be dredged is composed of fine silts. Additional loss of material occurs during the transfer of the material. The problem is more severe than with the clamshell dredge.

5.1.3 Dipper Dredges

On this unit (Figure 5-2), an articulated arm forces the bucket into the sediment and then raises it above the water on to a receiving barge (EPA/COE, 1978). The lower part of the bucket is opened by a cable mechanism to release the sediment. The cutting edge of the bucket is provided with teeth to increase the point of pressure on the material to be dug (Powers, 1980).

Many new dipper units have replaced cable mechanisms with hydraulic systems to improve their operation (COE, 1979a). Dipper dredge bucket capacities range from eight to 12 cubic yards. The "Rialto M. Christensen", owned by the Panama Canal Company, has a 15-cubic-yard bucket and is said to be the largest dipper dredge in the world (Powers, 1980). A typical dipper dredge can dredge nearly 2500 cubic yards per 24-hour day, or slightly over 100 cubic yards per hour, but the production rate varies according to the nature of the sediment to be dredged (sticky clay will take longer to dig and longer to be dumped) and the depth which, as it increases, increases the time needed for lowering and raising the bucket (COE, 1979a). If the dredging depth is so great that the dipper dredge can be used only during low tide, the production rate then decreases. Maximum dredging depths are usually limited to approximately sixty feet (Bray, 1977).

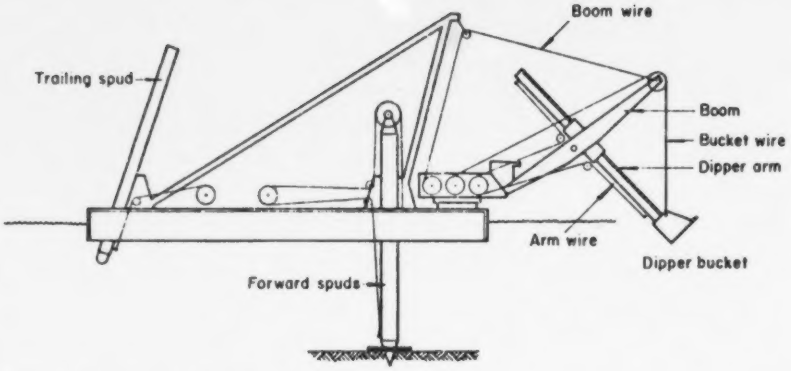
The dipper dredge can operate in almost any kind of soil, including loose rocks, boulders and clay, but will do poorly in very fine silts (Bray, 1977). One feature of the dipper dredge, and bucket dredges in general, is the high concentration of recovered material they achieve. For that reason many contractors own bucket dredges in additon to hydraulic dredges, while some operate only bucket dredges, finding them more efficient overall.

The operating cost of an average size dipper dredge has been estimated to be about $2.50 a cubic yard (COE, 1977a), but the same variation in price mentioned earlier can be expected. Many contractors around the country own dipper dredges, and buckets can easily be purchased.

The dipper dredge is powerful and disturbs the sediments while dredging, combined with a significant loss of material (Bray, 1977).

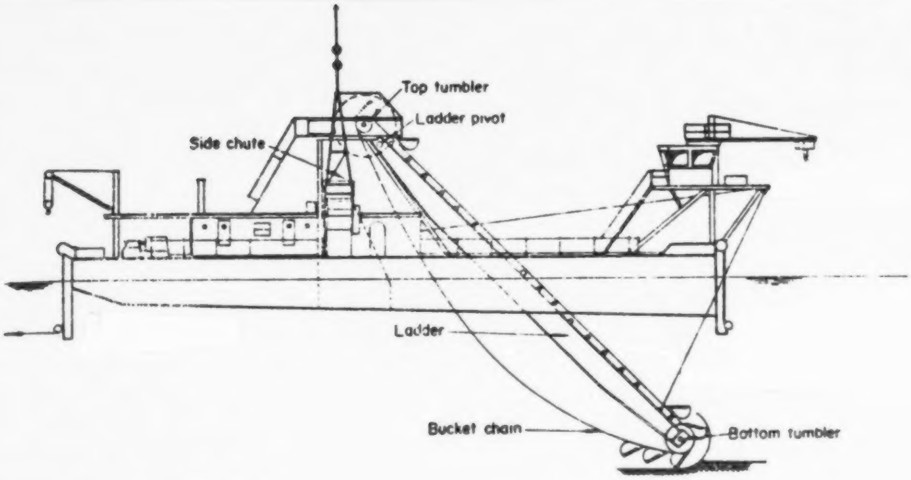
5.1.4 Bucket Ladder Dredges

This dredge (Figure 5-3) is frequently employed in Europe but is seldom found in the United States where its use has been


Boom wire
Trailing spud
Boom
Bucket wire
Dipper arm
Arm wire
Dipper bucket
Forward spuds

Source: Redrawn after Bray 1979

FIGURE 5-2
DIPPER DREDGE


Top tumbler
Ladder pivot
Side chute
Ladder
Bucket chain
Bottom tumbler

Source: Redrawn after Bray 1979

FIGURE 5-3
BUCKET LADDER DREDGE

restricted to the mining and recovery of sand, gravel and sometimes gold. The dredging unit consists of a continuous chain of buckets passing over a hinged ladder. The ladder is lowered to the bottom and each bucket digs into the bottom sediment and transports the material back to the surface (EPA/COE, 1978; COE, 1979a).

The chain is suspended from an upper tumbler and is guided and supported by a ladder, at the lower extremity of which is a lower tumbler. The lower end of the ladder is suspended from a hoisting gantry by means of a tackle. The bucket chain is driven by the upper tumbler, mounted on the main gantry. When each bucket reaches the lower tumbler, the underlying soil is dislodged by the rim of the bucket, and fills the bucket, which then commences its journey up the face of the ladder. In order to achieve a continuous dredging process, the vessel is swung from side to side with the aid of anchors and wires and the vessel's own winches. Guide rollers mounted on the ladder support the loaded buckets as they are drawn upwards. When each bucket passes over the upper tumbler, it is automatically emptied, the material falling into a sloping chute mounted on the main gantry and sliding down into barges moored alongside (Powers, 1980). One such dredge, the "Big Dalton" built by IHC, Holland features a movable bucket ladder gantry that enables the length of the ladder to be varied from 51 feet to 188 feet. "The gantry, which supports the ladder ... can be unbolted from the frame, swung around to the opposite side of the tower, using an installed crane, and rebolted for the longer ladder configuration, this operation can be achieved totally using equipment on board" (Powers, 1980). The capacity of the "Big Dalton" bucket is 0.65 cubic yard. Each bucket has holes in the bottom to drain excess water. Other ladder bucket dredges in Europe have bucket capacities ranging from 1.5 to 6.5 cubic yards. A bucket ladder dredge can achieve a production rate of nearly 2000 cubic yards per hour.

The bucket ladder dredge has been traditionally used in the recovery of sand and gravel and sometimes precious minerals and gold. It performs well in almost any soil as well as sedimentary rocks. As one could expect, it works poorly in sticky clays and very fine silts (Bray, 1977). This type of dredging unit is unsuitable for working in wave conditions and is best used in sheltered bays and deltas. The bucket ladder dredge is also well adapted to cutting channels, as the base of the ladder can be raised above the waterline, the removal of soil at or just above the level water can be achieved and the bank is thus undermined and dislodged, a practice known as "predredging" (Powers, 1980).

Bucket ladder dredges have not been popular in this country and are not manufactured here. There appears to be renewed interest, however, because of their high productivity and high recovery of material. Ellicott Corporation, a well known American company, has now built a new concept bucket ladder dredge which, since it is hydraulically powered, will be discussed in Section 5.2.6.

High turbidity has always been associated with bucket ladder dredges and was the main reason for their unpopularity in this country. The U.S. owners of the "Big Dalton" indicate they have had no significant problem with turbidity, and attribute this to a better design of the bucket.

5.1.5 Backhoes

Even though this unit is of relatively minor importance, it is worth mentioning since it has been used extensively on smaller projects and seems to be coming back on the market under the form of "giant backhoes", better designed and more efficient, some of them hydraulically powered. This particular type of dredging unit consists of a traditional backhoe mounted on a barge or a pontoon and secured to the bottom by three or four spuds (Hoffmann, 1978b).

The bucket size ranges from two to 6.9 cubic yards and the production rate can be expected to be equal to that of a dipper dredge. Turbidity is an obvious environmental drawback.

5.2 Hydraulic Dredges

Widely used in the United States, hydraulic dredges are essentially composed of a suction line, a centrifugal suction pump, and a discharge line. The dredged material is evacuated by pipeline, stored in hoppers, or pumped directly to a terrestrial or aquatic disposal site, depending on the specific dredge used (COE, 1979a). The following hydraulic dredges are reviewed:

- plain suction pipeline dredge,
- cutterhead suction dredge,
- dustpan dredge,
- trailing suction hopper dredge,
- sidecaster,
- bucket wheel dredge,
- Mudmaster,

- Delta Dredge,
- MUDCAT, and the
- Waterless Dredge.

General characteristics of hydraulic dredges are summarized in Table 5-2.

5.2.1 Plain Suction Pipeline Dredges

This dredge, simple but efficient, is equipped with a plain suction pipe which "vacuums" loose material. The flow of the material into the suction pipe can be facilitated by the application of one or more waterjets (EPA/COE, 1978). Such dredges operate at a maximum depth of 70 meters and are most efficient in dredging non-cohesive material (Bray, 1977). Strategically located booster pumps along the pipeline help convey the dredged material to distant disposal sites. Since the principles of the simple suction dredge are embodied in the design of the cutterhead suction dredge, the following description of the cutterhead suction dredge will cover them both.

5.2.2 Cutterhead Suction Dredges

The cutterhead suction dredge (Figure 5-4) functions on the same principle as the dustpan dredge (presented next) but differs from it by the design of the suction head which, in this case, is equipped with a rotating cutter which can dig into all types of alluvial materials and compacted deposits such as clay and hardpan. Different cutters allow the dredging of softer materials, such as basalt and limestone, or as hard a material as coral. Cutterheads are not, as they were often advertised, rock cutters. The angle of the cutter blade has a considerable influence on the efficiency of its operation. The dislodged material is forced into a pipeline by the suction action of a centrifugal pump. The "teeth" on the cutterhead are usually made of manganese carbon steel and designed so that they are easy to replace (Cooper, 1975). The cutterhead dredge can effectively pump dredged material through floating and shore discharge lines to disposal sites. With the help of strategically located booster pumps along the pipeline, the material can be pumped to disposal sites located at great distance from the waterway being dredged. In main navigation channels the pipeline can be submerged in order to reduce possible hazards to navigation. This type of dredge is not generally self-propelled. It is controlled on stern-mounted spuds and swung from one side of the channel to the other by anchored wires (EPA/COE, 1978). However,

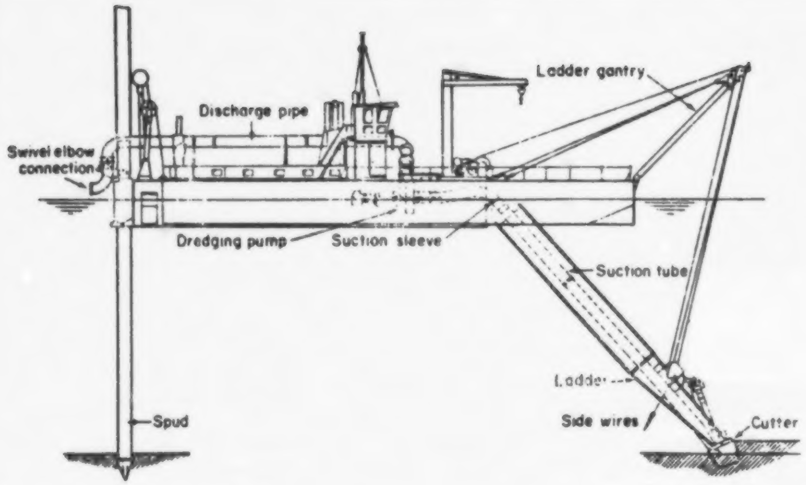
TABLE 5-2

GENERAL CHARACTERISTICS OF HYDRAULIC DREDGES

Name (Type)	Best Suited For	Production Rate	Means of Disposal	Environmental Drawbacks General Drawbacks	Cost of Operation ($ per cubic yard)[1]	Maximum Dredging Depth (Feet)
Plain Suction Pipeline (self propelled or onsite positioning by tugs)	medium hard to soft soils, loose sediment	variable, similar to cutterhead	pipeline or pipeline and barge	minimum turbidity	$2-3 or more	230
Trailing Suction Hopper Dredge, Self Propelled	medium hard to soft soils	fill 3710 yd^3 hopper in about 1/2 hr or less	into hoppers or pipeline	turbidity	$2.50	115
Cutterhead Dredge	almost any kind of soil	up to 200 yd^3/hr in soft soils, 150 yd^3/hr in blasted rock.	pipeline or pipeline and barge	turbidity	$2-3 or more	100
Dustpan Dredge	river beds, relatively soft to soft material, sand, clays, mud	1070 yd^3/hr up to 3500 yr^3/hr	pipeline or pipeline and barge.	high turbidity	$.44-.88	18
Sidecaster	maintenance of waterways and rivers	about 330 yd^3/hr	casting	turbidity	$1.30	60
Mudmaster	light or medium hard soils	up to 300 yd^3/hr	pipeline	minimum turbidity	only capital costs available	18
Delta	silt or soft material	up to 300 yd^3/hr	pipeline	minimum turbidity	only capital costs available	16
MUD CAT	silt, sand, muck, weeds, sludge and industrial wastes	up to 150 yd^3/hr	pipeline	minimum turbidity	only capital costs available	10-15 depending on model
Waterless	soft material, industrial wastes	up to 200 yd^3/hr	pipeline	minimum turbidity	only capital costs available	10-15

[1] These figures only give an indication of operational cost. Prices are highly variable according to the nature of the work, the distance between the dredging project and the disposal site, and the method used for disposal.

Sources: Delta Dredge and Pump Corporation, 1980
Dredge Masters International, Inc., Undated
Holland, 1981
MUD CAT Division, National Car Rental System, Inc., Undated
U.S. Environmental Protection Agency and U.S. Army Corps of Engineers, 1980
U.S. Army Corps of Engineers, 1979a
Waterless Dredging Company, Undated


Ladder gantry
Discharge pipe
Swivel elbow connection
Dredging pump
Suction sleeve
Suction tube
Ladder
Side wires
Cutter
Spud

Source: Redrawn after Bray 1979

FIGURE 5-4
CUTTERHEAD SUCTION DREDGE

one of the latest developments in the dredging field is the self-propelled cutterhead suction dredge (built by the Belgian firm of "de Cloedt et Fil Cie"), which still uses a spud but a steel piston pushing against the spud advances the dredge six meters before repositioning of the spud is required (Hoffman, 1978a). It can work in relatively rough seas and can cross the ocean for transoceanic work (Hoffman, 1978). Modern cutterhead suction dredges are also equipped with a dredging pump (situated well below water level on the ladder which supports the suction pipe) for increased efficiency.

Extended digging has been achieved on a pipeline cutterhead designed by Orenstein & Koppel of Aktiengessellschaft in Lubeck, West Germany. The 66-foot dredging capability of the cutterhead was extended to 131 feet by hinging the ladder as far back in the dredge hull as practical, then gaining positive control over the extended ladder by lifting gear mounted on the bow. The invention has been adapted to an American dredge, the "Western Condor" (COE, 1979a).

The cutterhead is adapted to dig into a wide variety of bottom sediments ranging from hard corals to limestone and muds. It is probably because of this factor that the cutterhead dredge is so popular all over the world (Bray, 1977). Another positive feature about the cutter suction dredge is its production rate, which can be as high as 2,000 cubic yards per hour for a large dredging unit in mud and soft clays (EPA/COE, 1978). The cost of operation varies greatly with the nature of the sediment to be dredged, but is usually a minimum of two to three dollars per cubic yard (Holland 1981).

One definite improvement in modern dredging technology has been the introduction of interchangeable parts, which make the same hydraulic dredge adaptable to practically any set of conditions. Ellicott Corporation, for example, produces a standard line of hydraulic pipeline dredges ranging from 500 to 5,000 horsepower. Various "cutter modules" of different designs can simply be added on each of these dredges, according to the needs encountered (Ellicott Corporation, Undated). Statistics for typical units owned by several U.S. corporations are given in Tables 5-3 through 5-5.

5.2.3 Dustpan Dredge

The Dustpan Dredge can be classified as a hydraulic, plain suction, self-propelled dredge (Figure 5-5). As its name indicates, this dredging unit's suction head resembles a large vacuum cleaner or dustpan, which is about as wide as the width of the hull it is

TABLE 5-3

ELLICOTT CORPORATION CUTTERHEAD SUCTION DREDGES

Model	Discharge Pipe Diameter (inches)	Total Power (Horsepower)	Hourly Production (cubic yard per hour)	Maximum Digging Depth (Feet)	Maximum Discharge Length (Feet)	Cost[1] of Unit (Dollars)
770 "Dragon"	12-14	730	450/580	26'	3000	500,000 to 550,000
970 "Dragon"	14-16	930	450/580	33'	5000	600,000 to 650,000
1470 "Dragon"	16-18	1390	450/790	42'	7000	900,000 to 950,000
1600 "Dragon"	18-20	1515		50'		
3000 "Super Dragon"	22-27	3234	900/1700	58'	11,000	
4500.Al "Super Dragon"	22-27	4510	900/1700	58'	11,000	
5000 "Super Dragon"	27-33	5755	1200/2700	58'	17,000	
6000.Al "Super Dragon"	27-33	5860	1200/2700	58'	17,000	
7000 "Super Dragon"	27-34	6806		100'		
10,000 "Super Dragon"	27-34	10,970		100'		

---

[1] Final prices depend on the optional equipment, accessories and pipeline requirements for specific jobs.

Source: Ellicott Machine Corporation, Undated.

TABLE 5-4

C.F. BEAN CORPORATION
CUTTERHEAD SUCTION DREDGES

Dredge	Hull Size (Feet)	Suction/Discharge (Inches/Inches)	Pump Horsepower
Jim Bean	262x65x15	29/27	9,200
Buster Bean	215x45x10	29/27	4,750
Lenel Bean	165x40x9	29/27	4,600
Kitty Bean	116x45x8	24/20	1,750
Pipeliner	65x24x6	14/12	600
Dredge No. 52	180x52x11	35/27	3,750
Dredge No. 85	81x26x7	20/16	1,500
Dredge No. 32	200x49x11	35/27	3,750
Bill Bauer	248x50x13	36/30	6,000
Blackburn	180x52x11	30/27	3,750
Holland	145x41x10	30/24	3,600
Borinquen	120x36x8	24/20	1,600
Shary	175x50x12	30/27	3,750

Source: Bean Dredging Corporation 1980.

TABLE 5-5

AMERICAN MARINE AND MACHINERY CO., INC.
CUTTERHEAD SUCTION DREDGES

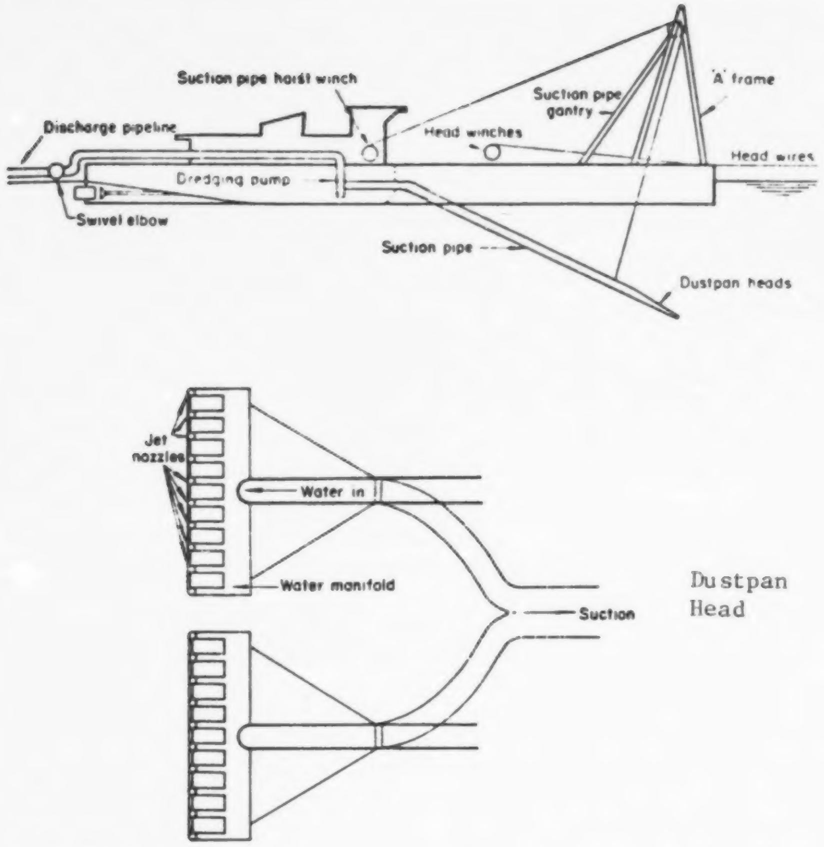
CUTTERHEAD SIZE (INCHES)	MODEL	TOTAL HORSEPOWER*	HOURLY PRODUCTION (CUBIC YARDS)**	DISCHARGE DISTANCE (FEET)**
6	PD-6S	115	100	1500
8	PD-8S	175	150	2000
	PD-8C	365	200	2500
10	PD-10S	480	250	3000
	PD-10E	540	250	3000
	PD-10C	695	275	4000
12	PD-12E	695	350	4000
	PD-12C	905	400	5000
14	PD-14S	905	500	5000
	PD-14SL	1025	600	6000
	PD-14C	1215	600	6000
16	PD-16L	905	700	4500
	PD-16SL	1025	800	6000
	PD-16S	1215-1490	800	7000
	PD-16C	2065	900	7000
20	PD-20S	1490-1645	1000	7000
	PD-20C	2065-2220	1200	7000
	PD-20D	2430-2980	1200	7000
24	PD-24D	2980	1500	7000
27	PD-27L	2980	2000	7000
	PD-27	4615-5715	3000	9000

---

*Based on manufacturers continuous duty ratings.

**Production capacities and discharge distances are variable depending on on-site conditions.

Source: American Marine and Marchinery Company, Inc. 1980.


Suction pipe hoist winch
'A' frame
Suction pipe gantry
Discharge pipeline
Head winches
Head wires
Dredging pump
Swivel elbow
Suction pipe
Dustpan heads
Jet nozzles
Water in
Water manifold
Suction
Dustpan Head

Source: *Redrawn after Bray 1979*

FIGURE 5-5
DUSTPAN DREDGE

installed upon. This suction head is outfitted with high velocity water jets which dislodge the silt and sands and form a mixture of sand and water at the entrance of the suction pipe; that mixture is then pumped through a floating discharge line to a spoil disposal area. The suction head, suction line, and waterjet line are mounted on a structural ladder hinged in a well section located in the forward part of the dredge. The suction head is pulled into the material by winches taking in two cables that run upstream to anchors set above the cut area (COE, 1979a). A discharge pipe of various configurations is connected to the stern and then to a floating pipeline (Herbich, 1974).

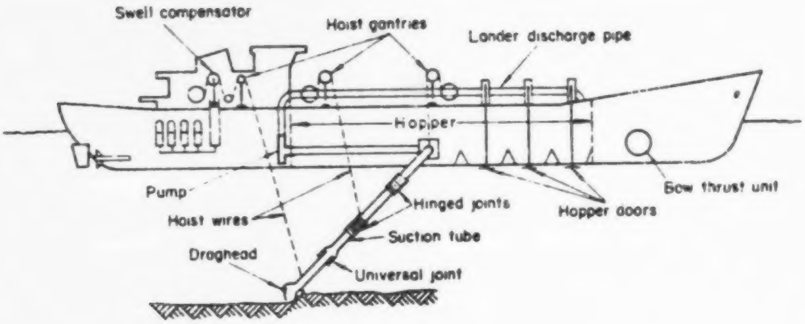
As can be seen from its design, the dustpan dredge is best adapted for dredging river beds. The first dustpan dredge was built for use on the Mississippi River. Thanks to its wide suction head, the dustpan dredge has a particularly wide dredging swath through the bottom sediments, which makes this type of dredge particularly advantageous for river channel dredging. Experience indicates that best results are obtained when cuts do not exceed six feet in depth. Production rates for the dustpan dredge are difficult to predict or calculate, but often they can exceed that of a 30-inch diameter cutter suction dredge by as much as 1,000 cubic yards per hour (3,500 cubic yards vs 2,500 cubic yards). Because of its bulky design, the dustpan dredge has to move out of the navigation channel periodically to maintain traffic flow, which reduces its annual production by more than 50 percent.

The Corps of Engineers owns most of the operational dustpan dredges in the United States, which are used mainly for channel maintenance work in the Mississippi River. As a result of the Industry Capability Program initiated by the Corps of Engineers in 1976, the C.F. Bean Dredging Company constructed the first privately owned dustpan dredge. The "Lenel Bean" has a 38-inch discharge and is operated by a 3,600 horsepower pump. It achieves a production rate of about 60,000 cubic yards per 24 hours at a cost ranging from 44 to 88 cents per cubic yard. The Ellicott Corporation in Baltimore also now builds dustpan type dredges.

The dustpan dredge does create a high level of turbidity. However, it is designed primarily for riverbed dredging where turbidity is often not a significant concern, due to naturally high levels.

5.2.4 Trailing Suction Hopper Dredges

This type of dredge (Figure 5-6) functions on the same principle as the plain suction pipeline dredge. It is, however,


Swell compensator
Hoist gantries
Lander discharge pipe
Hopper
Pump
Hoist wires
Draghead
Hinged joints
Suction tube
Universal joint
Hopper doors
Bow thrust unit

Source: Redrawn after Bray 1979

FIGURE 5-6
TRAILING SUCTION HOPPER DREDGE

equipped with hoppers to store the hydraulically dredged material (EPA/COE, 1978). Split hopper hydraulic dredges feature hoppers or bins which "split" open at the disposal site. No bottom doors, sliding or otherwise, are needed for the material to be dumped. This system also permits a better control over watertightness (d'Angremond, 1978). The hopper capacity varies from 300 to 11,700 cubic yards. The hopper dredge is equipped with large centrifugal pumps similar to those utilized by suction dredges. The craft is self-propelled. The material is raised by dredge pumps through one or two dragarms which are connected to each side of the ship or to the centerline by trunnions. These trailing pipes are literally dragged along the bottom ("drag head"). They consist of a heavy head with projections to scarify the bottom. Water jets can also be used to disintegrate the soil. When the hoppers have been filled, the dragarms are raised and the dredge sails to the disposal site.

One of the largest trailing suction hopper dredges today is the "Prins der Nederlanden", which has a hopper capacity of 11,700 cubic yards, an engine power of 21,500 horsepower, an overall length of 470 feet and can dredge at a maximum depth of 115 feet. It pumps a load of 18,000 tons of material in one hour and can dump the entire load in five minutes. The two trailing suction pipes are mounted forward and are raised and lowered by gantries and electric winches. Each pipe pumps 28,775 cubic yards of material in an hour (Hoffman, 1978).

Another large trailing suction hopper dredge is the "Geopotes IX", which is one of Volker Stevin's largest dredges. Volker Stevin Dredging, a Dutch company, is becoming affiliated with the Bean Corporation, which could facilitate the introduction or the building of a craft such as "Geopotes IX" in this country. The "Geopotes IX" is 412 feet long, 69 feet wide, and has a hopper capacity of 8,360 cubic yards. It can dredge to a depth of 110 feet. The total power in the dredge is 11,000 horsepower (Hoffman, 1978). The dredge is positioned by a sophisticated electronic system and is equipped with "indicators of the slurry level in the hopper, indicators for the positions of the trailing heads in relation to the bottom, an automatic compensator for swell that keeps the trailing heads on the bottom at all times, a system of lights to indicate whether the hopper doors are open or closed, a system of lights to indicate the position of the various valves, and an automatic pilot to steer the ship on a straight course to the dump site" (Hoffman, 1978).

The trailing suction hopper dredge is very popular in Europe, where it is used mostly for the maintenance of harbors. Its being self-propelled reduces any hindrance to navigation so the port to be dredged does not have to close or reduce its normal traffic when dredging is taking place (d'Angremond, 1978). Its design allows it to cope with rough open sea conditions.

From 1906 to 1977 the only hopper dredges available for projects in the United States were those operated by the Corps of Engineers; these are now old and obsolete. The Corps of Engineers hopper dredge fleet consists of 14 units, two of them with a hopper capacity of 6,000 cubic yards or more, seven with a capacity of 2,000 to 6,000 cubic yards, and five with a capacity under 2,000 cubic yards. The extensive maintenance required by older vessels is very costly and results in a considerable loss of time. The construction of three new dredges has been authorized by the Congress, while older vessels are scheduled to be progressively retired as the expense of their maintenance makes then less cost effective. The new units will represent the nucleus of the federally owned hopper dredge fleet being developed in response to the Public Law 95-269 stipulations. This fleet will be required to meet emergency or national defense requirements and consists so far of one small dredge (hopper capacity 825 cubic yards) for use in shallow waters, one medium class hopper dredge (6,000 cubic yard capacity) and one large class hopper dredge (8,600 cubic yard capacity) (Murden, 1980).

The enactment of Public Law 95-269 and the resulting Industry Capability Program have given the industry the incentive and the opportunity to proceed with building new dredging units (Murden, 1980). Several recently constructed units are described below.

The "Long Island", built in 1971 by the Construction Aggregates Corporation and acquired by the Great Lakes Dredge and Dock Company in 1978, has a capacity of 16,000 cubic yards and is propelled by a tug fitted into a notch in the stern of the barge. It is equipped with dual pumps and dragarms. This vessel was originally equipped only for pumpout operations. However, it was modified during 1978 to include a bottom gate dumping capability, which improved its versatility. The "Manhattan Island", a split hull hopper dredge with dual pumps and dragarms, is owned by the North American Trailing Company (a consortium consisting of the Great Lakes Dredge and Dock Company and Ballast-Needham, a Dutch firm). It has a hopper capacity of 3,600 cubic yards and has performed well on the navigation projects on which it has worked for the Corps of Engineers. This vessel is not equipped for direct pumpout operations; however, it will probably be converted to include this capability. The "Sugar Island", owned by North American Trailing Company, has a hopper capacity of 3,600 cubic yards, and is a sister ship to the "Manhattan Island". It is equipped for direct pumpout operations. The vessel was placed in service in May 1979. The

"Eagle I", owned by the Eagle Dredging Company (a consortium consisting of the C.F. Bean Company of New Orleans and Volker Stevin, a Dutch firm), has a 6,300 cubic yard hopper capacity and features dual pumps, dragarms, and a split hull. The "Eagle I" is a good representative of current design technology.

Technical improvements, some of which have been applied in the construction of these modern hydraulic hopper dredges, include:

- asymmetric hopper configurations that facilitate dumping,
- increased hopper capacities without an increase in overall hull dimensions through better utilization of hull space,
- undivided hoppers to increase vessel stability and reduce dredge construction costs,
- maximum production, flow, density, and load meters of improved sophistication to determine when overflow begins to result in loss of material,
- horizontal sliding bottom dump doors that eliminate cumbersome rod and linkage systems (used with vertically operating dump doors), and eliminate hull protrusions to permit operation in shallow water while reducing door jamming,
- interchangeable draghead components that permit fast modifications on the draghead to suit bottom conditions and to facilitate replacement of worn parts,
- high pressure water jet scarifiers to increase the digging capability of the draghead,
- draghead mounted, submerged pumps to increase pumping efficiency at greater depth, and
- hydraulically operated swell compensators and electronically operated draghead with controls to maintain bottom contact of the draghead in increased sea states (COE, 1979a).

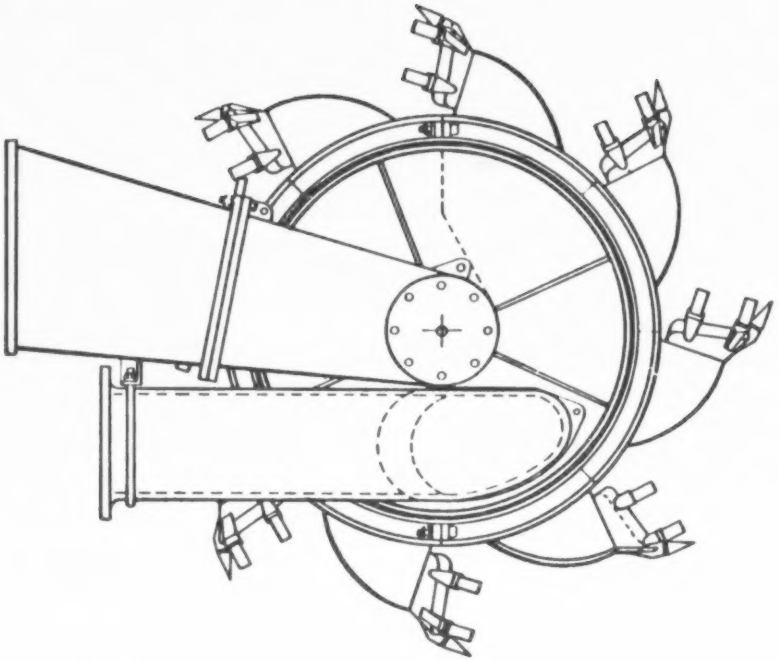
One particularly interesting device used for increasing the production rate is the submersible dredge pump. This unit seems to be a key factor in improving dredging efficiency. This system is now being widely used in this country (COE, 1979a). Tests indicate that a submerged pump can more than double the maximum output of a dredge at a 50-foot digging depth and quadruple it at an 82-foot digging depth. Booster jet pumps placed at submerged locations in the suction line can also increase the production rate by 25 percent to 50 percent. Dredging depths can be increased significantly with the help of submerged pumps. Such pumps can be adapted to a single draghead and the suction pipe is then converted to a delivery pipe. This relatively new and simple device greatly improves dredging efficiency at a minimum expense (COE, 1979a).

5.2.5 Sidecaster Dredges

The sidecast dredge is very convenient for use where the littoral currents do not return a significant amount of dredged material to the navigation channel, and in sandy inlets where it can be used with the double purpose of dredging and beach nourishment. In this case the diluted material is picked up and flows through suction piping and a centrifugal pump before being pumped back into the waterway, some distance away from the dredged channel. A typical side caster can dredge slightly more than 300 cubic yards per hour at an approximate cost of $1.30 per cubic yard (COE, 1979a). Its major drawback is the amount of turbidity created during its operation, particularly at the discharge point.

5.2.6 Bucket Wheel Dredges

In this type of dredge, the old fashioned bucket line of the bucket ladder dredge has been replaced by a bucket wheel mounted on the center of the dredge platform. As it rotates the wheel cuts into the sediments, brings the material back to the surface and unloads it on a conveyor system. This particular design allows the dredge to be used in a wide variety of sediments, making the system very versatile. Bates (1979) describes the two latest bucket wheel dredges. The first is the "wheel dragon" built by Ellicott Machine Corporation in Baltimore, Maryland. The "wheel dragon" (Figure 5-7) is the latest addition to Ellicott's 30-year old "dragon" series, the first family of standardized portable dredges ever put into regular production in the United States. The second was built by IHC, the Dutch dredge and shipbuilding company. In the "wheel dragon", the loaded bucket passes over a suction inlet chamber, located within the inner circumference of the bucket wheel, into which the spoil is discharged, partly under gravity and partly by suction. The system allows for the recovery of a very high concentration of solids and positive containment within the bucket walls minimizes spillage. The diameter of the bucket wheel is two, three, or more times greater than an equivalent crown cutter, and hence, the depth of material removed in a single pass is much greater. Forward steps are, however, slightly smaller (Bates, 1979). The "wheel dragon" efficiently excavates on both starboard



Source: Ellicott Corporation 1980

FIGURE 5-7
ELLICOTT "WHEEL DRAGON" EXCAVATOR

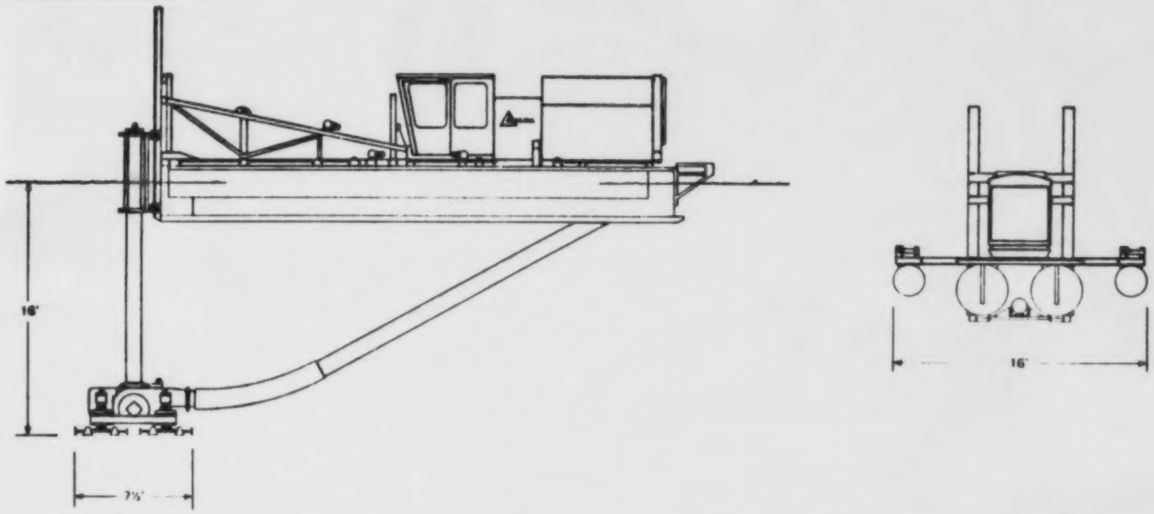
and port swings to produce a continuous flow of material. It permits control of slurry flow by variation of wheel speed and swing speed, thus greatly improving recovery of excavated solids (Bates 1979).

5.2.7 Mudmaster

The "Mudmaster" is built by Dredge Masters International (Hendersonville, Tennessee). The Mudmaster comes in three basic models, with a broad range of power applications and pump sizes. The "Mini-Mudster", the smallest model ranges from four-inch discharge diameter and 40-horsepower, to six-inch and 93-horsepower. The "Mighty Mudster", mid-range or medium duty machine, ranges from six-inch discharge diameter and 93-horsepower to eight-inch and 175-horsepower. The "Super-Mudster" heavy duty dredge, ranges from eight-inch and 190-horsepower, to ten-inch and 275-horsepower. According to the manufacturer, the Mudmaster features a combination ladder/main frame design which is a new concept in small dredges design. All main machinery is mounted on a single ladder/main frame structure, thereby eliminating the center hull section, deckhouse, "A-frame", gantry and suction hose. The new arrangement is designed to facilitate economical construction, ease of mobilization and assembly, simplicity of operation and maintenance, and high operating efficiency. The flotation of the dredge is provided by two rectangular steel side pontoon sections, based on a "catamaran" type design. The design also enables the Mudmaster to operate and work at an extremely shallow depth. The Mudmaster can also be easily transported from one job to another on one truck and, in most cases, fully assembled. An open suction "dustpan attachment" is available to handle most loosely compacted and free-flowing materials. The pontoons come in different configurations (rectangular, wedge, or delta shaped) adaptable to any kind of situation. An amphibious package is also available for dredging in swampy or marshy areas.

5.2.8 Delta Dredge

Built by Delta Dredging Company, St. Louis, MO., the Delta Dredge Model 212 (Figure 5-8) was developed in 1975. It is described by EPA/COE (1978) as lightweight dredging equipment featuring a double cutterhead in a sumbmerged 12-inch discharge pump. It can pump its discharged slurry up to 2,000 feet without a booster, and can dredge up to 100 cubic yards of sand per hour and up to 300 cubic yards per hour of silt or soft material. The hull contains four pontoons, and the operating draft is 32 inches. The two counter-rotating, reversible cutters provide a relatively shallow seven foot wide cutting swath, and the unit has a digging



Source: *Delta Dredge and Pump Corporation 1980*

FIGURE 5-8
DELTA DREDGE

depth of 16 feet. It is reported that the turbidity levels are low. The dredge is 16 feet wide and 40 feet long and weighs 15 tons. It is portable for ease of transport and maneuverable in small bodies of water. The unit can be used to clean out silted lakes, industrial settling ponds and sewage lagoons. According to the manufacturer, the equipment dredges a high percentage of solids.

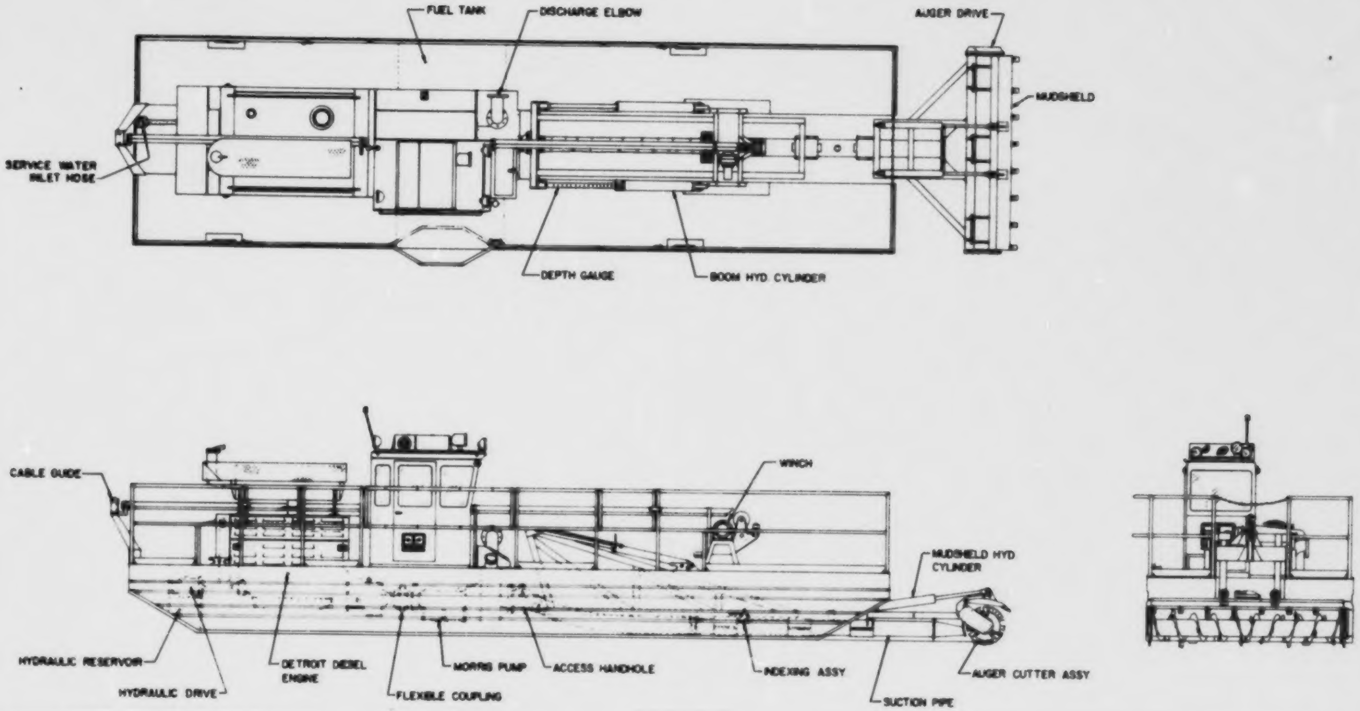
The current price of the Delta Dredge is approximately $240,000. A larger version of the Model 412 is now in use, pumping slurry at 5,000 gallons per minute (vs 4,000 gallon per minute on the 412 model). This unit is also equipped with sophisticated intrumentation, including a nuclear density meter and a flow meter. The cost is about $450,000 (Delta Dredge and Pump Corporation, 1980).

5.2.9 MUD CAT

The MUD CAT (Figure 5-9) is a small, portable suction cutterhead dredging unit featuring a horizontal auger-like cutter which is lowered into the sediment by an hydraulically operated boom. A patented auger cutter with mudshield assembly is mounted at the end of the boom and equipped with a variety of interchangeable cutter knives to dislodge and/or cut up material. The selection of the proper knives is dependent on the type of material to be removed. A spiral auger in the cutterhead drives the material to a suction pump intake. This rotating, cutting action can remove sediments in a nine-foot wide swath down to a depth of 15 feet. It has a minimum draft of 21 inches. The auger can be rotated from horizontal up to a 45 degree angle to accomodate slopes of lakes and of settling ponds. The mudshield extends beyond the cutterhead, entrapping suspended material and minimizing turbidity. Eight-inch diameter pipe is supplied in 19-foot sections, which can be hand assembled over land or water. The MUD CAT can typically discharge 2,000 gallons per minute with a solids concentration of 10 to 40 percent or up to 150 cubic yards of material per hour, the production rate varying with the nature of the sediment to be dredged (Shenman, 1981; MUD CAT Division, undated).

It is propelled by a reversible, variable speed, hydraulically powered winch on a traversing cable anchored on shore and moves from side to side using a system of "pullover" cables. The MUD CAT is successively moved in forward and reverse directions, dredging bottom sediments with flat bottom cuts in both directions. The "pullover" cables reposition the dredge laterally, parallel to and overlapping previous cuts (MUD CAT Division, undated).

The MUD CAT can be transported to a site on a flat-bed trailer from which it is normally launched with a crane. It can cut up and


FUEL TANK
DISCHARGE ELBOW
AUGER DRIVE
MUDSHIELD
SERVICE WATER INLET HOSE
DEPTH GAUGE
BOOM HYD CYLINDER
CABLE GUIDE
WINCH
MUDSHIELD HYD CYLINDER
HYDRAULIC RESERVOIR
HYDRAULIC DRIVE
DETROIT DIESEL ENGINE
FLEXIBLE COUPLING
MORRIS PUMP
ACCESS HANDHOLE
INDEXING ASSY
SUCTION PIPE
AUGER CUTTER ASSY

Source: Mud Cat Corporation 1980

FIGURE 5-9
MUD CAT

pump away a variety of bottom sediments including silt, sand, muck, weeds, sludge, and industrial wastes, at a rate ranging from 45 to 150 cubic yards per hour, depending on the nature of the sediment to be dredged.

The MUD CAT was recently evaluated as a mechanism for removal of polluted sediments. It was noted that the resuspension of the dredged material was minimal and that 99.3 percent of the four materials tested were effectively removed (EPA, 1976). The MUD CAT dredge is reportedly convenient and easy to use, especially in shallow areas. Its hydraulically adjustable mudshield helps reduce turbidity to a minimum, a very important factor which makes the MUDCAT valuable in removing polluted materials from bottom sediments.

The MUD CAT dredge comes in two different sizes. The SP-180 model, or "Mini MUD CAT", is designed for the smaller jobs. Without accessories, this model costs approximately $75,000. The model MC-915 is a new, larger, and improved dredge. Without accessories, this model's cost is about $116,000 (MUD CAT Division, 1981).

5.2.10 Waterless Dredge

The Waterless Dredging Company, Mattoon, Illinois, has developed a dredging system (Model 8-180) in which the cutter, which operates like a paddle wheel, and a pump are enclosed in a cylindrical shroud. Totally shrouded for minimizing turbidity and rotatable to provide equal efficiency in cutting on left and right hand swings, the cutterhead is forced into the material and the cutterblades remove the material near the front of the cutterhead with little entrainment of carrier water. This machine is reported to dredge material with a solids ratio of 30 to 50 percent, creating a minimum amount of turbidity. The centrifugal dredge pump is a fully submerged as an integral part of the cutterhead for maximum efficiency (Waterless Dredging Company, undated). This approach has the advantage of limiting the water content of each gallon of sludge removed, which in turn minimizes the dredging time and cost of the operation by reducing the total amount of material to be removed (Stefanides, 1980). The waterless dredge is moved forward and backward by cables. A weed cutter attachment is also available.

5.3 Pneumatic Dredges

Three dredging units function on the pneumatic principle

- o the Airlift

- o the Oozer, and

- o the AMTEC Pump.

General characterisitcs of pneumatic dredges are summarized in Table 5-6.

5.3.1 The Airlift

The principle of operation of this unit is simple. Compressed air is injected in a partially submerged recovery pipe, at some point below the water surface. The bouyant air rises to the surface creating a flow of water through the pipe capable of carrying solids. The air lift pump is more efficient in deep water as the air expands under reduced pressure and accelerates the flow through the pipe. The solids-to-water ratio ranges from 15 to 70 percent depending on the pump design. The unit can be mounted on a conventional dredge, which, through the help of widely spaced anchors and walking spuds, can gain lateral movement.

Air lift dredging pumps are not readily available since they are usually assembled for a special purpose, but they have been used for many years and have the advantage of creating a minimal amount of turbidity. Air lift pumps have been mostly used for the removal of silt and sediments at salvage sites, and by archeologists in the Mediterranean Sea to expose artifacts (COE, 1979a).

5.3.2 The Oozer

Designed and made in Japan, the Oozer (Figure 5-10) is a pneumatic pump dredge which operates by using water pressure to raise the dredged material, its suction power being increased by creating a vacuum in the tank. The mixture flows into the tank, then compressed air expells the mixture from the tank to the delivery pipe. Two tanks working alternatively are used, which assures a constant flow of the material and increases the unit efficiency (Nishi, 1976).

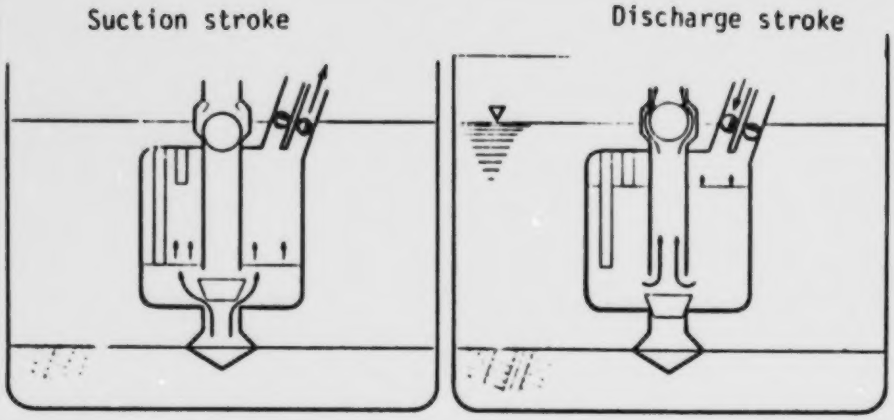
A portable oozer type dredge is available in Japan with the following dimensions: overall length 65 feet, beam 26 feet, draft 6 feet, dredging depth 19 feet. A larger dredge, the "Taian Maru", has a length of 121 feet, a breadth of 39 feet, a draft of 7 feet and an excavation depth of 55 feet. This unit also features one or two underwater cameras, depending on the model, to monitor the dredging operation in the areas around the suction attachments. The amount of turbidity can be then checked on a T.V. screen, where the shaded area indicates the amount of turbidity not to be exceeded. A recorder prints a final record of the actual dredged material so that after-dredging surveys are not needed (Wooton, 1980).

TABLE 5-6

GENERAL CHARACTERISTICS OF PNEUMATIC DREDGES

Name	Best Suited for	Production Rate	Means of Disposal	Availability	Environmental Impact	Cost U.S. Dollars	Maximum Dredging Depth (Feet)
Airlift	soft silts and sediments	very variable	pipeline to recovery barge	available in U.S.	low turbidity		
Oozer	any kind of soil, viscous clayey, sandy sediments	523 yd^3/hr (30-70% solid ratio)	pipeline or barges	available in Japan, represented by TJK, Inc. 7407 Fulton Ave., No. Hollywood, California 91605	minimum turbidity and secondary pollution. sophisticated environmental monitoring system	$2,577,251	56
AMTEC Model 36	sand, sludge clays and silts	600 yd^3/hr (slurry)	pipeline or barges	available from AMTEC Development Company 1550 Berkeley Road Highland Park, FL 60035	minimum turbidity		1-200

Source: U.S. Army Corps of Engineers 1979a
Jensen, R. 1979
Maloblocki R. 1981


Suction stroke
Discharge stroke

Source: Jensen, TJK, Inc. 1981

FIGURE 5-10
OOZER PUMP SYSTEM

The Oozer has been especially designed for dredging heavily polluted sludge. A 20-foot long, 6-foot wide metal hood covers the suction mouth and recovers any oil or gas contained in the sediments. Below this hood is another cover over the suction mouth to prevent turbidity and secondary pollution. The density of the dredged material shows a 30 to 70 percent solids content compared to a typical hydraulic dredge that pumps 20 percent solids and 80 percent water. The decrease in the amount of water pumped into a disposal site has a significant impact on the size of the required disposal area and facilitates the drying of the sludge (Wooton, 1980). The dredging capacity of the unit when pumping over a distance of 3,000 feet is in the range of 3,000 cubic yards per day. The Oozer is particularly suited for the dredging of viscous materials, but it can be used in a variety of bottom sediments.

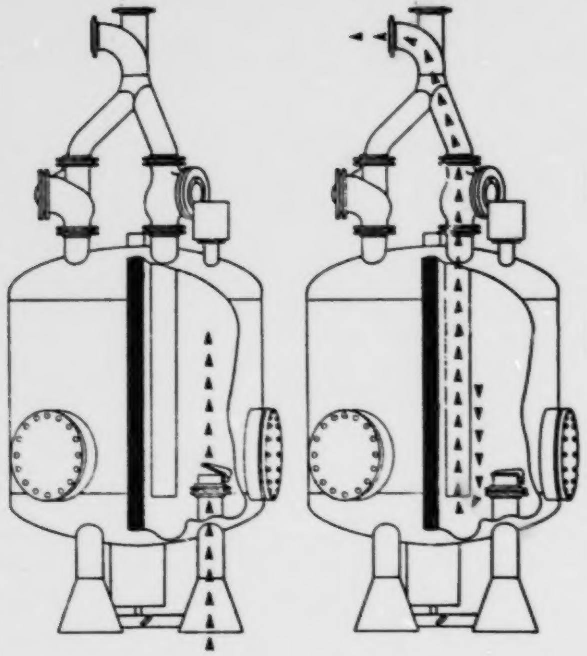
According to Jensen (1981), the Oozer dredge equipment and barge could be purchased at the cost of about $2.6 million. The dredge could be readied and moved to the east coast of the United States in approximately 105 days. Transportation could cost 1.0 to 1.4 million dollars, depending upon the method used.

From an environmental protection point of view, the Oozer presents the following advantages:

- it reduces turbidity, which has been a constant subject of concern in dredging, to a minimum;
- it permits the extraction of polluted material with a high density ratio, thereby minimizing the cost of transportation and disposal;
- monitored by high precision electronic devices, it eliminates the need for after-dredging surveys and provides precise information on the dredging operation as it takes place;
- the Oozer can be used in almost any site; for example, special cutters have been designed for relatively hard soils; and
- because of its vacuum operating pump system, the dredging power of the Oozer is not affected by the depth (Jenson, 1981).

5.3.3 The AMTEC System

The AMTEC pneumatic pump (Figure 5-11) was designed by the AMTEC Development Company, Highland Park, Illinois. The AMTEC dredging pump, Model 3.6 SPECS works on the pneumatic principle.



INTAKE
CYCLE
DISCHARGE
CYCLE

Source: Amtec Corporation 1980

FIGURE 5-11
AMTEC PUMP SYSTEM

The pump is comprised of three chambers. The intake and discharge functions are repeated at split second intervals in each chamber as described by the manufacturer:

- a three way valve functions to create a vacuum in one of the chambers;
- when ready, the inlet valve opens...slurry enters induced either by hydrostatic head pressure or vacuum action;
- as the slurry reaches a certain level, the electronic sensoring device issues a command to the electronic controller for the three-way valve to close;
- at its turn, the three-way value is given a command to introduce pressurized air into the chamber;
- this pressurized air forces the slurry down, then up and through the "wye" discharge pipe; and
- from the "wye" discharge, the slurry is conveyed through a pipeline to a disposal area (AMTEC Corporation, 1981).

An electronic device, connected to the pump by a cable, controls the functions of each chamber. It determines when the slurry has filled the chamber to its capacity and, at the same time, it coordinates the action of each of the three chambers, issuing commands for intake and discharge, as appropriate. The electronic controller also adjusts the operation automatically as the density of the slurry and depth of operation change.

The AMTEC Standard Model 3.6 SPECS achieves a production rate of 600 cubic yards of slurry per hour. The depth of operation can vary from one to 200 feet and the length of discharge can be up to 3,000 feet. The pump can be supported by a crane or any other suspension device. A larger AMTEC pump is also available which could achieve about twice the production rate (AMTEC Development Corporation, 1981).

The AMTEC pneumatic pump is, according to the manufacturer, a versatile dredge which could be used in a variety of situations such as cleaning up sludge basins, dredging behind docks and piers, mining sand or minerals, dredging pollutants, and maintaining marinas and boat slips. The AMTEC would seem to be particularly well adapted to the dredging of polluted material, since the pneumatic principle allows for an efficient vacuuming of bottom sediments, which keeps resuspension of material to a minimum.

5.4 Ancillary Equipment

In addition to the actual dredging plant, certain other types of equipment may also be used to minimize environmental impacts or to improve efficiency. Two areas of particular interest are silt curtains and positioning equipment.

5.4.1 Silt Curtains

Silt curtains, or turbidity barriers, are devices that are used to control the movement of turbid water away from the dredging or disposal site (Johanson, 1976). Early attempts to use silt curtains in turbidity control were only partially successful because of the type of equipment. The first curtains used pervious filter cloth or untreated canvas. Flotation was provided by logs, lobster floats, and barrels. Chains, cans of concrete, sections of pipe, and the like were used as ballast, attached to grommeted holes in the bottom edge of the curtain. The curtains were held in place by tying them to poles driven into the bottom. The pervious material quickly became plugged with silt, grew heavy, and sank. The untreated canvas supported marine growth, soon deteriorated and disintegrated. Storms invariably destroyed the curtains. Such primitive attempts, with their attendant serious problems, undoubtedly formed the basis for the negative opinions which have survived and are present in the industry today (Johanson, 1976).

To offset these problems, the early materials were replaced with various thicknesses of polymeric films, which, while light in weight and resistant to the chemical attack of the marine environment, were insufficiently sturdy to withstand the intrusion of large marine life and the abrasion and chafing of the support poles, ultimately tearing, and failing to contain turbidity. Poles and timber supports, were replaced by conventional anchoring systems, and the polymeric films were strengthened with embedded woven fiber reinforcement. Flotation and ballast were heat-sealed into the material to become integral members of the commercial silt curtain (Johanson, 1976). The curtains that are now being used are are much more practical to install, easier to maintain, and considerably more effective.

5.4.2 Positioning Systems

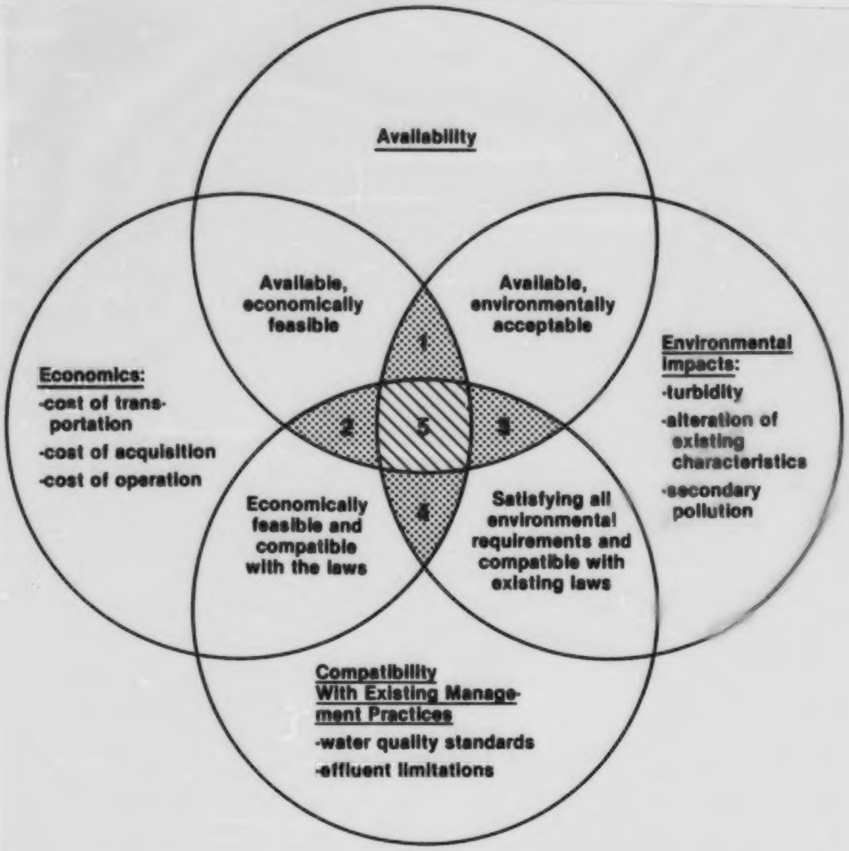
New advances in electronics have led to a considerable improvement in positioning accuracy, which allows more accurate dredging. Positioning and monitoring dredging activities have become a computerized operations, which provides the project manager with printouts indicating the existing channel depth, gives pre- and post-dredge profile plots and calculates volumes. The printouts themselves can be used as proof of performance, eliminating the need for costly overdredging. One of these systems, built by Engineering Service Associates, Inc in Washington, D.C. is called the Tellurometer Model MRD-1. Its cost ranges between $61,500 (two range system) and $78,000 (three range system). Other systems are available, such as the "Mini Ranger" by Motorola. These sophisticated systems are valuable additions to the regular dredging equipment and allow great savings of time and money spent in overdredging.

6.0 PROCEDURES FOR EVALUATION OF ALTERNATIVE TECHNOLOGIES AND MANAGEMENT PLANS

Early in the preparation of this report a private dredging contractor ventured the opinion that, while very advanced technologies do indeed exist, they are usually not available and much too expensive to acquire in any case. This opinion is probably held by a majority of industry representatives. On the other hand, many environmental groups would assume that any expense would be justified. One method of overcoming this polarity is to develop reasonable, quantitative (or at least semiquantitative) criteria for evaluation of alternatives. This should, in theory, limit the discussion to those alternatives which offer some benefits to all parties affected by such decisions. In this report we have attempted to review potential options in such a manner, using the following criteria:

- Economics - does the option compare favorably with the costs of the component it would replace?
- Availability - can the option be obtained (or implemented) in a reasonable period of time?
- Environmental impacts - does the option offer increased environmental protection or aesthetic improvement?
- Compatability with existing management practices - are there legal or regulatory constraints which must be overcome?

The relationship of these criteria, with respect to evaluation of a potential alternative, is shown in Figure 6-1 and discussed briefly in the following sections. Ideally, of course, it is desirable to find options which satisfy all criteria (area five on Figure 6-1), but these are the least numerous. Developing options which satisfy three of the four is more likely (areas one through four on Figure 6-1), but then priorities must be set for the various criteria. These priorities will vary depending on the view point of the evaluator. For example, the owner of a dredging company is likely to emphasize economics and prefer options which satisfy this criterion. Such an individual, if given the choice of options in areas one through four in Figure 6-1, would probably not select one from area three (option is available, environmentally acceptable, compatible with existing management practices, but not economical). While the diagram in Figure 6-1 is obviously a simplification, it does highlight the interaction of the various criteria, each of which is discussed in more detail below.



Availability
Available, economically feasible
Available, environmentally acceptable
Environmental Impacts:
-turbidity
-alteration of existing characteristics
-secondary pollution
Economics:
-cost of transportation
-cost of acquisition
-cost of operation
1
2
5
3
4
Economically feasible and compatible with the laws
Satisfying all environmental requirements and compatible with existing laws
Compatibility With Existing Management Practices
-water quality standards
-effluent limitations

1 Dredging Unit is available, environmentally acceptable and economically feasible, but it is not compatible with existing management practices.
2 Dredging Unit is available, economically feasible, compatible with existing management practices, but environmentally not acceptable.
3 Dredging Unit is available, environmentally acceptable, compatible with existing management practices, but it is not economically feasible.
4 Dredging Unit is environmentally acceptable, economically feasible, compatible with existing management practices, but it is not available.
5 Dredging Unit is available, environmentally acceptable, compatible with existing management practices, and economically feasible.

FIGURE 6-1
SCREENING CRITERIA USED FOR CHOOSING NEW DREDGING TECHNIQUES

6.1 Economics

Economic considerations must play an important role in any evaluation of this type, since someone ultimately must pay for any new technology. This becomes particularly critical if industry is expected to bear the entire financial burden of required changes, since ecological or social benefits do not accrue to the dredger. If the cost is to be borne by the state or federal regulatory agencies, then the problem becomes one of cost/benefit analysis. The parameters to be considered vary from case to case, but may include:

- capital costs,
- operational and maintenance costs,
- unit cost of dredging,
- secondary or ancillary costs, or
- costs relative to the "next best" option.

In 1980, nearly twelve million dollars were spent on dredging federal projects in the Norfolk District, and five million dollars were spent in the Baltimore District. Even at that funding level work is being deferred due to budgetary constraints. With the demand for ever-deeper channels expenditures must go up, and will be driven even higher if inflation continues at a high pace. In this environment it is not surprising to find that user charges are a topic of interest in Congress, but even that approach could not pay for major increases in unit costs. Dredging on private projects is even more constrained. It is simply unrealistic to assume that, except in cases of extreme need, equipment which greatly increases costs would be used.

6.2 Availablity

This criterion has an element of both economics and legal constraints in it. In assessing any alternative technology for near-term implementation in the Chesapeake Bay, one must be sure that it is, in fact, available. For example, large hopper suction dredges are available in the United States, but they could be fully employed elsewhere. Since dredgers will utilize the most efficient and cost effective technique allowed, any decision on the part of regulatory agencies to encourage the use of alternative equipment would have to be based on the knowledge that such equipment could be obtained.

6.3 Environmental Impacts

Environmental criteria have gained more and more importance over the last ten years. At the same time, they are not reflected in the marketplace; that is, the true worth of environmental resources is not included in the cost of dredging. In this sense we rely on government to provide protective regulations, based on the value of the resource to society as a whole. Potential issues, which would vary from project to project, include:

- substrate compatibility,
- persistence of impacts,
- impacts to shellfish areas,
- impacts to fishery nursery or spawning areas,
- impacts on benthic faunal reproduction,
- toxicity, both lethal and sublethal,
- effects on water quality,
- public health impacts, or
- aesthetic impacts.

6.4 Compatibility with Existing Regulatons

Options which meet all or some of the other criteria still must be compatible with existing laws and regulations, or they cannot be implemented immediately. It is, of course, possible to change existing laws or regulations. It is equally possible to prepare new ones to encourage the use of approaches which are less often used in a free market situation. Particularly critical are areas in which the laws or regulations (or their implementation) are imprecise or inconsistent. Dredging companies, as all other industries, are reluctant to invest in new or unproven equipment in the face of regulatory uncertainty.

7.0 EVALUATION OF POTENTIAL MODIFICATIONS IN TECHNOLOGY OR MANAGEMENT PRACTICES

7.1 Screening of Available Options

Based on the data assembled in this report, a series of possible options, both technological and managerial, were developed for evaluation. This evaluation was restricted largely to the dredging process itself; we have made no attempt to evaluate disposal practices in detail. An attempt was made to make the list as inclusive as possible without becoming overly specific. The options considered were:

- use of improved dredging equipment on large projects,
- increased use of silt curtains,
- use of improved navigation or positioning equipment,
- use of pneumatic dredges for polluted material,
- increased use of hydraulic or pneumatic dredges on small private projects,
- establishment of turbidity standards to replace seasonal dredging moratoriums,
- increased chemical and bioassay testing of sediments,
- development of comprehensive monitoring studies to clarify long-term impacts,
- use of advanced treatment methods in confined disposal areas,
- establishment of additional confined disposal areas,
- further improvement to the permit review process,
- revisions to the effluent standards for upland disposal areas, and
- repeal or modification of the Jones Act.

Each of these options is discussed in terms of the applicable criteria (Section 6.0) in the following sections.

7.1.1 Use of Improved Dredging Equipment on Large Projects

While there is a large variety of technological improvements available on the market, there appears to be little reason for the regulatory agencies to intervene directly by requiring the use of specific equipment. At the present time, dredgers in the Chesapeake Bay rely almost entirely on hydraulic cutterhead dredges. Economics dictated this choice for large projects and will also encourage implementation of new technologies. Interestingly, more efficient, and hence more economical, techniques are also generally more environmentally acceptable. Key environmental issues associated with the type of equipment used are governed by the production of suspended sediment and by the degree of water entrainment with the dredged material, both of which decrease with increased efficiency. In addition, more efficient operation limits the temporal extent of any impacts, a further beneficial impact. In the case of most projects, the impacts associated with turbidity are so minimal, however, that mandating improvement through requiring the use of specific equipment is not justified. This choice should be left to the dredging companies.

7.1.2 Increased Use of Silt Curtains

The performance of silt curtains has improved dramatically over the past several years. JBF Scientific Corporation (1978) reviewed the current state of the art, and there is little doubt that in some circumstances silt curtains could appreciably reduce turbidity. It is equally clear that they could cause a significant increase in cost on many projects. Their most efficient application would be on long-duration projects, or at disposal sites being utilized by more than one project. Availability is not a problem and their use is compatible with current management practices.

While it is clear that the use of silt curtains would decrease turbidity, it is not clear that this would result in a significant environmental improvement, since there is little to indicate that present levels are harmful. The most beneficial use of such equipment would be to protect particularly sensitive habitats in localized areas of the bay, if such areas could realistically be shown to be threatened by a particular project. The mathematical and physical models to accomplish this evaluation exist and should be used.

7.1.3 Use of Improved Navigation or Positioning Equipment

Use of modern electronic gear for navigation and positioning can greatly reduce the need for overcutting, a definite economic benefit. It also produces positive environmental impacts by reducing the dredging time and the total volume of material for disposal. Use of such equipment would appear to be in the best interest of all parties and should be encouraged by the regulatory agencies. The type of equipment should not be specified, but performance standards, or bonus payments, could be established which would encourage innovative technologies. In most cases the inherent economic advantages of such equipment already act to encourage their use on large dredges.

7.1.4 Use of Pneumatic Dredges for Polluted Material

The Japanese Oozer Dredge (Section 5.3.2), as well as the AMTEC Pump (Section 5.3.3), could be considered for use in polluted areas of the Chesapeake Bay. The Oozer is the only unit which has seen any significant use in this type of application. It was specifically designed for the dredging of heavily polluted harbors in Japan. The cost of acquisition of a complete Oozer unit could be as much as 2.5 million dollars, with an additional one to 1.5 million dollars in transportation costs. Operational costs are not known. The justification for this type of expenditure would have to be based on the existence of an essential project which simply could not be dredged safely using conventional technology or on the presence of a sufficient number of moderate priority projects where the unit could be employed nearly constantly, in order to amortize the initial cost. The literature available from the AMTEC Corporation suggests that the AMTEC Pump might be capable of similar performance characteristics. The total cost of building a large-scale dredge based on the AMTEC unit is not known, but might be considerably less than the importation of an Oozer.

Either unit would accomplish two desirable goals: turbidity at the dredge site would be minimized, and much less water would be entrained with the sediment. These are obvious advantages in polluted areas. The difficulty lies in determining at what point use of this type of equipment is justified. At the present time there are no criteria which can be applied.

While the AMTEC unit is produced domestically, the Oozer would be an imported unit and would fall under the jurisdiction of the Jones Act (Section 3.1.3). At the present time its importation would appear difficult, if not impossible. According to Scholle (1981), the prohibition against the use of foreign-built dredges may be waived by the U.S. Customs Service in specific cases when deemed necessary in the interest of national defense by the Secretary of Defense. An alternative might be to purchase only the Oozer pump for adaptation to a U.S. built dredge (COE, 1979a).

7.1.5 Increased Use of Hydraulic or Pneumatic Dredges on Small, Private Projects

Small portable hydraulic dredging units are now available from several companies. Most have been designed in the last ten years. The use of such equipment would appear to be more efficient than the mechanical methods now commonly used. A small hydraulic dredge could achieve a production rate in the range of 300 cubic yards per hour, while a five cubic yard bucket dredge will only produce 150 cubic yards per hour.

Small hydraulic units, such as those discussed in Sections 5.2.7 through 5.2.10, can be acquired at costs ranging from $75,000 to $250,000, or may be leased from the manufacturer. Because these small dredging units can easily be transported by truck to the dredging site, mobilization and demobilization costs are reduced to a minimum. The Maryland National Capital Park and Planning Commission recently acquired a MUD CAT dredge for the maintenance of the Safford Marina in Maryland. This acquisition was considered to be the best long-term solution, since the marina had to be maintained on a regular basis. The MUD CAT achieves a production rate of 200 cubic yards per hour, and at the Safford Marina, disposal of the dredged material is accomplished directly by pipeline, thereby eliminating the supplementary costs of rehandling the material from barges to trucks. The dredge is now owned by the Commission and kept at the dredging site.

These small dredging units are good examples of modern dredging technology, featuring maximum efficiency and various monitoring devices for additional turbidity control. The design of the suction head (often equipped with a mudshield), along with maximum suction power achieved by underwater pumps located as close to the suction head as possible, minimizes the resuspension of particles and secondary pollution problems. Small dredges have been used extensively for cleaning up industrial ponds where viscous polluted material had to be removed. Industrial wastes are usually composed of extremely fine silts which cannot be handled by mechanical dredges because the material sticks to the bucket, or by large hydraulic units since they cannot be maneuvered in small enclosed areas.

Small dredging equipment is environmentally acceptable, and even desirable, as it allows for the removal of sediments with minimum disturbance in the dredged area. Problems may arise, however, at the disposal site, since most material from the small private projects where these units are likely to be used is disposed of at upland sites. In both Maryland and Virginia, various laws and regulations regarding effluent standards would have to be met. This can be a problem, especially when dredged material is pumped hydraulically in a slurry form and carried directly by pipeline to the disposal area. A great deal of water (40 to 60 percent, depending on the nature of the dredged material) runs off from the disposal area back to the body of water. The fear of investing in machinery which, on some projects, might not be used as it was designed to be without elaborately engineered disposal sites, has apparently discouraged dredging companies from acquiring this kind of equipment.

7.1.6 Establishment of Turbidity Standards to Replace Seasonal Dredging Moratoriums

Seasonal restrictions are a common subject of complaint among dredgers. A moratorium of up to six or seven months is imposed on many projects, usually covering spring, summer and/or fall, or the periods of the most intense biological activity in the bay. Dredging during the winter months is a very difficult operation, sometimes impossible if the upper bay is covered by ice. Down time increases as a result of rough weather conditions, injuries to workmen increase, and the working efficiency is significantly reduced. As a result, the cost to complete a given project rises.

While any seasonal restrictions are based on a case by case review, they are largely based on "worst case" analysis, in which the probability of the potential adverse impacts does not play a role. What few data are available, including the study by Cronin (1970), suggests that there is limited justification for blanket restrictions of the type sometimes imposed in the past.

Since most increases in turbidity are highly localized and of short duration, it would appear more realistic to establish "turbidity limits" (which could change seasonally) that dredgers would not be allowed to exceed for areas in need of protection. The dredger could then determine the most efficient means of achieving this level. Preliminary analyses could be based on the mathematical and physical models now available, but this approach would require a monitoring program to check for compliance. In many cases it would appear that present methods could be demonstrated to be acceptable if the dredger had a standard for comparison. The preparation of such "turbidity limits" could be accomplished relatively easily by scientists familiar with natural turbidity and biotic patterns in the bay. This approach could require more bay-wide field studies of background levels, although a beginning could be made with existing data.

During the review of this report the following comment was received from the Tidewater Administration of the Maryland Department of Natural Resources:

> Evaluation on a worst case basis is inherently necessary. If all parameters could reasonably be expected to operate perfectly and in a vacuum, environmental review would be unnecessary. This is not the case; Murphy's law applies. Because it is economically and administratively difficult to rebuild a destroyed resource it must be given adequate protection through suitable dredge project restrictions. Any other action would be to neglect the public trust.

It is our opinion that nothing in this comment indicates any reason why a different approach to regulaton should not be investigated. The studies cited in Section 4.2, especially the work by Schubel and Meade (1977) and Schubel et al. (1980) suggest that appropriate in-water turbidity standards could be developed. If, after an evaluation of the concept is completed, it can be shown to involve greater risk than current practices, then the old standards could be retained. Or, if necessary, they could be retained for particularly sensitive areas of the bay. While the present approach used by the State of Maryland is certainly effective in eliminating impacts, there is little evidence to support their contention that the same protection could not be achieved in a more economical manner.

7.1.7 Increased Chemical and Bioassay Testing of Sediments

A great deal of uncertainty and controversy surrounding dredging in the Chesapeake Bay relates to the issue of dredging contaminated sediments. Neither the Baltimore nor the Norfolk District requires chemical testing as a general condition for project approval, either federal or non-federal, unless a 401 or 404 permit is involved, and then only if there is reason to suspect contamination. No bioassay testing is required. As a result, data on the chemical composition of the sediments dredged in the Chesapeake Bay over the past eleven years are limited. In addition, there is no agreement as to what level of contamination (or bioassay results) would require special treatment, either for dredging or disposal. In all fairness, the agencies of the Chesapeake Bay are no worse off in this regard than most other similar organizations. However, if reasonable management decisions are to be made, a better understanding of the quality of the sediments of the bay would appear to be essential.

This would result in increased dredging project costs. If it were to be borne by the private sector, some consideration would have to be given to the small applicant, who could not afford the possible cost of several thousands of dollars for a series of bioassay tests.

The Norfolk District, as part of its program to obtain approval for an ocean disposal site, has instituted an extensive bioassay testing program in Norfolk Harbor (see Section 4.2.2). This program could serve as a model for future federal evaluations in other regions of the bay, but the approach is probably much too expensive for private applicants, unless the projects are quite large. The results of the Norfolk study do suggest, however, that large-scale, one-time surveys, if conducted properly, could be used to exempt uncontaminated areas from further testing.

7.1.8 Development of Comprehensive Monitoring Studies to Clarity Long-Term Impacts

As discussed in Section 4.2.3, one of the major concerns with dredging and open water disposal is the lack of a clear understanding of long-term sublethal impacts. Impacts at the dredging site are fairly well understood, and, although there is continued concern over turbidity increases caused by dredging, most impacts are of short-term duration and/or resonably predictable. The long-term impacts of open water disposal were a major consideration in the Dredged Material Research Program (DMRP) of the Corps of Engineers. In that program field investigations were conducted at sites in Long Island Sound, the Columbia River, Lake Erie, the Gulf of Mexico, and Puget Sound (Saucier et al. 1978). The results of these studies confirmed that direct impacts (other than physical alterations) were generally short-lived; however, the period of performance was inadequate to assess questions relating to possible changes in long-term community structure, bioaccumulation of contaminants, effects on reproductive capacity, and increased susceptability to disease, among others.

Since the completion of the DMRP in 1978, a follow-on program, the Dredging Operations Technical Support (DOTS), has provided the Corps with a mechanism for assisting the field offices in implementing DMRP technologies. This program included limited funding for continued low-level monitoring studies at selected DMRP field sites. In FY 1982 a new five-year research program, Long-Term Effects of Dredging Operations (LEDO), was initiated at the Waterways Experiment Station. The principal objectives of LEDO are to provide new or improved technology to predict long-term (including cumulative) environmental impacts of dredging operations and to address methods of minimizing any adverse impacts (U.S. Army Corps of Engineers, 1981).

Since none of the long-term Corps of Engineer's disposal site studies are in the Chesapeake Bay, it would be valuable to conduct at least one such study at a disposal site in the region. This would provide valuable information for the crucial decisions concerning future disposal programs which will have to be made as the Hart and Miller Islands and Craney Island sites reach capacity. Such a study should not be undertaken lightly, however, since at least five to ten years worth of data from a well-designed study would be necessary to even begin to address most long-term issues.

7.1.9 Use of Advanced Treatment Methods in Confined Disposal Areas

The treatment of hazardous wastes is an area of rapid technological improvement at this time, primarily due to the implementation of the Resource, Conservation and Recovery Act by EPA. Polluted dredged material could fall under the implementing regulations and hence require special treatment.

One possible treatment is a soil fixation process developed in Japan specifically for the treatment of polluted dredged material (Wooton, 1980). The technique is meant for use with the Oozer dredge, and requires a high solids content. Portland cement and an additive to lock up the toxic chemical are added to the dredged material. The material, after drying for three days in a disposal area, is transported by truck to a landfill operation, where it can be disposed of without the threat of leaching.

There are innumerable other approaches which could be utilized, but they all have one common aspect, they are considerably more expensive than any disposal practices now in use. While they clearly would reduce the danger associated with polluted sediments, there are no studies which can be used to evaluate their necessity in the Chesapeake Bay.

7.1.10 Establishment of Additional Confined Disposal Areas

The existence of the Craney Island disposal site in the Norfolk District has greatly modified disposal practices in the Norfolk-Hampton Roads area. Hart and Miller Island, once it becomes operational, will accomplish the same thing in the Baltimore area. Of course, neither site has an infinite capacity, and if open water disposal is to be discouraged in the future (as it appears to be presently), then additional areas will be required. Such areas could also be useful in other segments of the bay, if they were available for disposal of material from non-federal projects. Rehandling charges or users fees at such a site might be more attractive to private industry than the continual search for upland disposal areas.

Particular attention should be given to productive uses, such as the creation of marshes or repair of eroded areas. This is being done presently to a limited extent in the Baltimore District for the replenishment of Tangier Island. If properly designed, located, and operated, these sites appear to be relatively neutral from an ecological viewpoint. They are, of course, most useful for clean or moderately polluted material where the threat of leaching or effluent contamination can be shown to be minimal.

7.1.11 Further Improvement to the Permit Review Process

Steps which have already been taken have tremendously improved the permit application review process in both districts. A joint permit application has been effective in the Norfolk District since April 1978. In the Baltimore District, it is still necessary to obtain, in addition to the Corps of Engineers permit, a "wetland license" issued by the Maryland Department of Natural Resources, which includes a Water Quality Certificate issued by the Department of Mental Health and Hygiene. Hopefully, the district's goal of one application combining all various requirements will be achieved. The Norfolk District, in order to further reduce permit processing time, is considering the feasibility of determining cumulative environmental impacts in certain water bodies where there is a high degree of shoreline development. General permits could then be issued to cover certain activities within these water bodies. While these changes are certainly desirable, they will not solve the problems associated with controversial projects, either federal or private.

7.1.12 Revisions to the Effluent Standards for Upland Disposal Areas

Effluent limitations and various water pollution laws in both Maryland and Virginia have had an impact on dredging in the Chesapeake Bay. Costs involved in compliance appear to have encouraged the use of mechanical equipment for small dredging projects, since such techniques produce a more dense material. Mechanical dredging, however, often implies the rehandling of material for upland disposal, which adds to the costs and does not provide an efficiency comparable to hydraulic methods. The restrictions resulting from these regulations are resented by the dredging industry, who feel they are unjustified.

This issue is particularly important if upland disposal continues to increase in the Chesapeake Bay region. While there does not appear to be any justification for any immediate or major modifications to the laws, the environmental protection they afford does have an economic price, one that will increase as upland disposal sites become less available.

7.1.13 Repeal or Modification of the Jones Act

The Jones Act of 1920 (See Section 3.1.3) forbids dredging in the United States by foreign dredges. However, a foreign dredge, the "Big Dalton", built by IHC, Holland has recently been acquired by the Livingston Graham Land and Gravel Company. This vessel is a large bucket ladder dredge, a type of unit not manufactured in this country. That particular dredge was allowed to enter the United States and perform work in U.S. waters, since it was considered a special case and given special permission. In most cases, however, under existing regulations dredging companies prefer to avoid foreign dredging units, rather than go through all the administrative complications associated with acquisition.

The purpose of the Jones Act, protection of American manufacturers from foreign competition, would appear to be overstated when the technology of interest may not even be available in this country. For example, while the small portable Oozer unit described in Section 5.3.2 could be imported and mounted on an american built vessel, importation of the larger Oozer (vessel included) would probably violate the Jones Act. If the Act itself cannot be changed, then the possibility of simplifying the procedures for importation should be investigated. If necessary, a finding of unavailability in this country could be a stipulation for importation. There are, potentially, both economic and environmental benefits to this action.

7.2 Program Recommendations

Regulatory agencies, private contractors, environmental groups and legislative bodies all play a role in the development of dredging policy for the Chesapeake Bay. The preceeding discussions have suggested a few areas of particular concern for all or some of these groups. While the following recommendations may be controversial to some extent, and certainly could be expanded by other parties, we feel that their implementation, or at least consideration, would improve the conditions in the bay.

First of all, it is our basic conclusion that the overall environment of the Chesapeake Bay has not been adversely affected by dredging or disposal operations. While concerns over dredging and disposal of polluted sediments are certainly real, activities to date do not appear to have been harmful. The goal of all our recommendations, and, hopefully, of all concerned parties, is to ensure that this situation does not change for the worst. With that in mind, we suggest the following:

- Regulatory agencies should implement study programs to more clearly define the extent of contaminated sediments in the bay in relation to present and future dredging requirements. While it has been expensive, the current Norfolk District biological testing program will certainly provide the type of data not available in the past. This information is essential for sound management decisions, but will require some agreement on the term "contaminated" prior to its inception. When areas of concern are identified, plans should be made in advance with respect to how dredging and disposal should proceed when required.

- Better long-range planning for disposal options is required. This should be done for the bay as a whole and should consider the problems of disposal from small private projects as well as from large contracts. The apparent trend towards increased reliance on upland or confined disposal needs better justification.

- Use of innovative technologies should be encouraged but not required. One of the best methods of doing this is through performance standards, which allow the private sector to determine suitable responses. Specifying equipment to be used or imposing seasonal dredging bans suppresses innovation, since the costs are simply passed on to the government or to the private party responsible. This could possibly be done through incentive clauses for items such as: time to complete, limited overcutting, or limited turbidity, etc.

- Seasonal restrictions on dredging should be replaced by turbidity standards, since their justification appears to rely on unreasonable "worst case" assumptions, at least in terms of documented impacts.

- The Corps should investigate the possiblity of federal ownership of some type of advanced pneumatic dredge for use throughout the east coast on polluted sediments. Its purchase only for use in the Chesapeake Bay appears unjustified. Costs for private companies with no guarantee of sufficient work appear prohibitive.

- The portions of the Jones Act affecting dredging equipment are unnecessarily restrictive and should be repealed or modified to allow aquisition of foreign equipment.

The Corps of Engineers must bear the burden of most of these suggestions, but their implementation, or the implementation of any other innovative approaches, will require the active participation and cooperation of all those concerned with dredging in the bay.

APPENDIX A

DREDGING STATISTICS

TABLE A-1

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1970

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N* or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Baltimore Harbor -Cutoff Brewerton Angle	MD	496,879				112,601	M	Corps of Engineers	"Goethals" hydraulic	Overboard in approved disposal area	
-Craighill Cutoff Angle		387,433				87,429	M	Corps of Engineers	"Goethals" hydraulic	Overboard in approved disposal area	
-Connecting Channel to C&D Channel		157,422				30,837	M	Corps of Engineers	"Goethals" hydraulic	Overboard in approved disposal area	
-Cutoff Section		237,320				58,788	M	Corps of Engineers	"Goethals" hydraulic	Overboard in approved disposal area	
Bonum Creek	VA	3,959		14,950		14,950	M	American Dredging Company	Hydraulic 12" pipe-line	Upland both sides of channel	DACW31-70-C-0085
Chester River	MD	15,100 15,555 30,655	1.00 1.68	15,100 26,132	18,100 8,000	67,332	M	Cottrell Engineering Company	Hydraulic	Upland in diked area	DACW31-70-C-0086
Anocostia River	MD	83,300	0.83	69,139	15,000	84,139	M	Joe Brodesser Inc.	12" pipeline hydraulic		DACW31-70-C-0082
Ocean City Harbor and Inlet and Sinepuxent Bay	MD	41,900	1.00	41,565	8,000	49,565	M	Cottrell Engineering Company	Hydraulic	Overboard in authorized spoil area	DACW31-70-C-0030
St. Jerome Creek	MD	40,100	0.66	26,466	12,966	38,966	M	American Dredging Company	Hydraulic	Upland on Deep Point	DACW31-70-C-0085
Tilghman Harbor	MD	64,700	0.85	54,995	10,000	64,995	M	American Dredging Company	Hydraulic	Upland 500 feet northwest of Devils Island	DACW31-70-C-0085
Twitch Cove and Big Thorofare	MD	14,200	1.04	14,768	20,000	34,768	M	American Dredging Company	Hydraulic	Upland on Martin Wildlife Refuge	DACW31-70-C-0085
Rhodes Point to Tylerton	MD	107,711	0.96	103,403	9,000	112,403	N	Cottrell Engineering Company	Hydraulic	Upland	DACW31-70-C-0086
Island Creek St. George Island	MD	12,235	1.77	21,655		21,655	M	American Dredging Co.	Hydraulic	Upland on St. George Island	DACW31-70-C-0085
Lower Thorofare Deal Island	MD	44,300	0.95	42,085	18,190	60,275	M	American Dredging Co.	Hydraulic	Upland on Little Deal Island	DACW31-70-C-0063
Lower Wharf	MD	15,300	0.92	14,076	12,000	26,076	M	American Dredging Co.	Hydraulic		
Nanticoke River	MD	42,000	0.67	28,274	11,000	39,274	M	American Dredging Co.	Hydraulic	Upland 500 feet northwest of Devils Island	DACW31-70-C-0085

* Indication of New (N) or Maintenance (M) projects.

TABLE A-2

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1971

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N* or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Baltimore Harbor and Channels	MD										
-Craighill Cutoff		371,602				108,053					
-Cutoff Section		301,706				83,974		COE	Goethals	Overboard in approval spoil disposal area	
-Brewerton		303,236				61,175					
Section Cutoff		205,702				72,955					
Fishing Creek	MD	82,200	.80	65,964	15,000	80,964	M	Cottrell Engineering Co.	Hydraulic	Overboard in Chesapeake Bay South of Project	DACW31-71-C-0120
Monroe Bay and Creek	MD	5,500	2.59	14,250		14,250	M	Cottrell Engineering Co.	Hydraulic	Upland diked-disposal area Gum Bar Point	DACW31-71-C-0120
Twitch Cove and Big Thorofare	MD	51,900	.93	48,400		48,400	M	Cottrell Engineering Co.	Hydraulic	Upland-Overboard	DACW31-71-C-0120

*Indication of New (N) or Maintenance (M) projects.

TABLE A-3

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1972

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N* or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Baltimore Harbor and Channels	MD										
-Brewerton Angle		310,403				157,903	M	COE	Hopper dredge "Essayons"	Overboard in approved spoil disposal area	
-Craighill Cutoff Angle		471,830				163,993					
Goose Creek	MD	45,045	1.16	52,252	15,000	67,252	N	Cottrell Engineering Co.	Bucket/ dragline		DACW31-72-C-0046
Ocean City Harbor and Inlet and Pipe puxent Bay	MD	110,500	1.03	113,815	15,000	128,815	M	American Dredging Co.	16" hydraulic "Maryland"	Upland Northern portion of Assateague Island Rest (unsuitable) in surf zone	DACW31-72-C-0028

*Indication of New (N) or Maintenance (M) projects.

TABLE A-4

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1973

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N* or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Susquehanna River at Williamsport	PA	50,000 (estimate)				69,586	N	Langenfelder and Son.	Rental	Upland	DACW31-73-C-0130
Ocean City Harbor and Inlet and Sinepuxent Bay	MD	100,800	0.93	93,744	15,000	108,744	M	East Coast dredging Inc.	Hydraulic	Upland Assateague Island along beach face in surf zone	DACW31-73-C-0144
Susquehanna River above and below Havre de Grace	MD	30,922				124,381	M		12" hydraulic	Upland	DACW31-73-C-0130
Havre de Grace	MD	20,200	1.00	20,200	11,700	31,900	M	Fred J. Miller Inc.	Hydraulic	Used for beach replenishment	DACW31-73-C-0182

*Indication of New (N) or Maintenance (M) projects.

TABLE A-5

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1974

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N* or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Chester River	MD	51,364	1.45	74,477	24,500 9,800	108,778	M	Barnegat Bay Dredging Co.	Hydraulic	Upland diked disposal	DACW31-74-C-00
Anacostia River and Tributaries	MD	96,000	1.90	182,400	42,000	224,400	M	Spickard Ent.	Hydraulic	Upland	DACW31-74-C-0066
Honga River and Tar Bay	MD	47,200	1.55	70,060	67,900	137,960	M	Atkinson Dredging Co.	Hydraulic 16"	Open water	DACW31-74-C0059
Nanticoke River at Bivalve	MD	32,925	1.65	54,326	21,000	75,326	M	Barnegat Dredging Co.	Hydraulic	Upland diked area at "Cedar Hill Park"	DACW31-74-C-0075
Slaughter Creek	MD	13,000	1.76	22,880	10,000	32,880	M	Shelby Dredging Co.	Hydraulic	Taylors Island	DACW31-74-C-0070
Twitch Cove and Big Thorofare	MD	9,957				42,433	M	Atkinson Dredging Co.	Hydraulic 16"	Upland spoil site on land of the Martin National Wildlife Swamp Refuge	DACW31-74-C-0059

*Indication of New (N) or Maintenance (M) projects.

TABLE A-6

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1975

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N* or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Baltimore Harbor	MD										
-Craighill, Cutoff Angle	MD	558,710				391,704	M	Corps of Engineers	Hopper dredge "Essayons"	Overboard in approved disposal area	
-Brewerton Angle		229,506				181,380	M				
Knapps Narrows	MD	77,600	1.26	97,776	25,000	122,776	M	K.P. and B Company	Hydraulic	Open water, off Knapps Narrows Estuary	DACW31-75-C0043
Ocean City Harbor and Inlet and Sinepuxent Bay	MD	38,200	0.90	34,380	44,000	78,380	M	Cottrell Engineering Company	Hydraulic pipeline "Marion"	Upland on Assateague Island used for beach replenishment	DACW31-75-C-0070
Tred Avon River	MD	215,000	1.84	395,600	71,200	466,800	N	Spickard Enterprise	Hydraulic	Upland	DAWC31-75-C-0030

*Indication of New (N) or Maintenance (M) projects.

TABLE A-7

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1976

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N* or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Baltimore Harbor -Cutoff Angle	MD	608,300	0.71	431,893	12,000	443,893	M	American Dredging Company	Mechanical clamshell	Open water Patapsco River Mouth Disposal Area	DACW31-76-C-0062
Madison Bay	MD	54,400	1.15	62,560	45,000 6,500	114,060	N	Barnegat Bay Dredging Co.	Hydraulic	Upland	DACW31-76-C-0100
Naticoke River (incl. Northwest Fork)	Del MD	70,000 (estimate)				178,661	M	K.P. and B. Company	Hydraulic		DACW31-76-C-0082
Ocean City Harbor	MD	30,336	1.22	37,100	19,000	56,010	M	K.P. and B Company	Hydraulic	Beach north of inlet	DACW31-76-C-0056
Twitch Cove and Big Thorofare	MD	80,950	2.24	181,328	68,496	249,824	M	Cottrell Engineering Co.	Hydraulic	Upland-Easter Point	DACW31-76-C-0053
Upper Thorofare, Deal Island	MD	65,035	1.04	67,636	45,130	112,766	M	Cottrell Engineering Co.	Hydraulic	Upland on Deal Island	DACW31-76-C-0046
Wicomico River	MD	362,200	1.07	387,556	314,316	713,385	M	Atkinson Dredging Company	Hydraulic	Upland	DACW31-76-C-0084

*Indication of New (N) or Maintenance (M) projects.

TABLE A-8

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1977

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N* or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Baltimore Harbor -Craighill Angle	MD	623,624	0.91	523,250	12,000	535,250	M	American Dredging Co.	mechanical clamshell	Patapsco Site	DACW-31-77-C-0023
Fishing Creek	MD	55,670	1.55	86,289	60,000 12,812.80	159,101	M	Cottrell Eng. Co.	hydraulic	upland north-west of project	DACW-31-77-C-0027
Honga River and Tar Bay	MD	75,300	2.10	158,130.0	135,000.00	293.130	M	Barnegat Bay Dredging Co.	hydraulic	Barren Island Gap and Upper Tyler Cove	DACW-31-77-C-0092
Knapps Narrows	MD	43,550	1.64	71,422	87,400 13,756	172,578	M	Cottrell Eng. Co.	hydraulic	Upland north of narrows	DACW-31-77-C-0038
Rhodes Point to Tylerton	MD	40,910	1.80	73,638	36,800 18,800	129,238	M	Cottrell Eng. Co.	hydraulic	Upland at Tylerton	DACW-31-77-C-0026
Twitch Cove and Big Thorofare	MD	26,530	1.25	33,163	47,400	80,563	M	Cottrell Eng. Co.	hydraulic	Upland at Swann Island	DACW-31-77-C-0026
Tyler River	MD	18,310	1.25	22,888	16,000	38,888	M	Cottrell Eng. Co.	hydraulic	Upland at Easter Point	DACW-31-77-C-002
Chester River	MD	30,315	3.10	97,008	75,000	172,008	M	Barnegat Bay Dredging Co.	hydraulic and 12" pipeline	Upland diked disp. area	DACW-31-77-C-0091

*Indication of New (N) or Maintenance (M) projects.

TABLE A-9

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1978

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N* or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Baltimore Harbor -Cutoff Angle	MD	615,350	0.93	572,275	33,000	605,275	M	American Dredging Co.	mechanical clamshell	openwater Patupsco River	DACW-31-78-C-0039
-Pocomoke River	MD	111,507	2.49	277,652 93,977	99,560 111,208	488,510	M	Spickard Enterprise Inc.	hydraulic	upland in Pocomoke Sound	DACW-31-78-C-0013
Fishing Bay	MD	94,120	2.24	210,829	105,500 103,457 (modifs.)	419,785	M	Spickard Enterprise Inc.	hydraulic 12" pipeline	upland diked disp. site	DACW-31-78-C-80
Cambridge Harbor	MD	79,775	4.48	357,392	241,920	599,312	M	Cottrell Eng. Co.	hydraulic	upland	DACW-31-78-C-0008
Pentagon Lagoon	MD	25,400	16.50	419,100	50,000 61,916	531,016	M	Shirley Contracting Co.	mechanical clamshell	Upland (dryed adjacent to lagoon, than trucked to Arlington Cemetary	
Little Wicomico	VA	25,640	2.89	74,100	66,400 32,709	173,209	M	Fred J. Miller Inc.	hydraulic 12" pipeline	upland diked disp. area	DACW-31-76-C-0004
Ocean City Harbor and Inlet and Sinepuxent Bay	MD	44,800	2.65	118,720	25,600	144,320	M	Spickard Enterprise Inc.	hydraulic	Disp. along coast south of Ocean City nourishment beach	DAWC-31-76-C-0074
Wicomico River	MD	90,463	2.78	251,487	165,400 106,573	523,460	M	Cottrell Engineering Co.	hydraulic	upland	DACW-31-78-C-0081

*Indication of New (N) or Maintenance (M) projects.

TABLE A-10

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1979

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N* or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Crisfield Harbor	MD	54,250	3.50	189,875	108,000	297,875	M	Spickard Ent. Inc.	hydraulic 12" pipeline	upland diked disposal areas Jersey Island and little further north	DACW-31-79-C-0008
Lower Thorofare	MD	25,710	2.85	73,274	60,000	133,274	M	Spickard Ent. Inc.	hydraulic	diked upland disposal area 10.5 acres	DACW-31-79-C-0008
Deal Island	MD	75,336	1.04	83,494	104,416	187,910	N	Cottrell Engineering Co.	hydraulic	diked upland disposal area 10.5 acres	DACW-31-79-C-0008
Ocean City Harbor and Inlet and Linpuxent Bay	MD	60,614	2.47	149,717	100,000.00	249,717	M	Barnegat Bay Dredging Co.	hydraulic	upland disposal site north of Bend of on the Bay side	DACW-31-79-C-0023
St. Catherine Sound	MD	22,052	1.96	43,222	83,100	126,322	M	Cottrell Engineering Co.	hydraulic	upland on St. Margaret Island	DACW-31-79-C-0066
Island Creek St. George Island	MD	22,220	1.84	40,885	39,000	79,885	M	Cottrell Engineering Co.	hydraulic	upland on St. George Island	DACW-31-79-C-0066

*Indication of New (N) or Maintenance (M) projects.

TABLE A-11

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1980

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N* or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Baltimore Harbor and Channels: -Swan Point and Tolchester Sections	MD	872,340	2.67	2,329,148	100,000	2,429,148	M	Great Lakes Dredge & Dock Co.	mechanical clamshell	Overboard in approval Site: Pooles Island Deep	DACW31-80-C-0013
-Craighill Cutoff Angle	MD	615,000	1.72	1,057,800	110,000	1,167,800	M	American Dredging Co.	mechanical clamshell	Overboard in Patupsco River	DACW31-80C-0020
Washington DC Harbor	MD	3,583				44,241	M	Corps of Engineers Co.	Hydraulic Sidecaster "Fry"	Overboard adjacent to channel	
Ocean City Harbor	MD	38,636	2.97	114,749	204,144	318,893	M	Cottrell Engineering Co.	Hydraulic	Upland disposal site north of 32nd st. on the Bay side	DACW31-80-C-0034
Tilghman Island Harbor	MD	23,500	7.80	183,300	175,500	358,800	M	Spickard Ent. Inc.	Hydraulic	Upland	DACW31-80-C-0027
Knapps Narrows	MD	75,596	2.40	181,430	99,500	280,930	M	Spickard Ent. Inc.	Hydraulic	Upland and overboard	DACW31-80-C-0027
Anacostia River	MD	61,000	4.36	265,960	188,000	453,960	M	Spickard Ent. Inc.	Hydraulic	Upland	DACW31-80-C-0008

*Indication of New (N) or Maintenance (M) projects.

TABLE A-12

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1970

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Deep Creek Dismal Swamp Canal Feeder Ditch	VA	5,180 20,973 26,153	1.00 0.60	5,180 12,584 17,764	17,500	35,264	M	Higgerson & Buchanan, Inc.	12" pipeline dredge "Chesapeake"	Upland into Swamp	DACW65-70-C-0067
Jackson Creek Whiting Creek & the Rappahannock River	VA	203,099	0.54	109,852	30,000	139,852	M N	Atkinson Dredging Co.	16" pipeline dredge "Northwood II"	Open water in Piankatank River open water in Whiting Cr. on riverbanks by Spottswood Bar.	DACW65-70-C-0072
Cape Henry Channel	VA	538,750	0.87	469,675	67,511	537,186	M	Corps of Engineers	"Goethals"	Openwater in Chesapeake Bay east of York Spit Channel	
Rehandling Basin	VA	662,909	0.42	274,928		274,928	M	Norfolk Dredging Co.	22" pipeline "Pullen"	Craney Island	DACW65-70-C-0020
Waterway on Coast of Virginia	VA	232,455	0.67	153,276	74,720	227,996	M	Cottrell Engineering Co.	12" pipeline "Marion" & "Richmond"	Upland on marsh	DACW65-69-C-0025
York Spit Channel	VA	454,333	1.08	492,093	94,267	586,360	M	Corps of Engineers	"Goethals"	Open water in Chesapeake Bay, North east of Channel	
South Branch 35'	VA	483,850	.77	371,019		371,019		contractor	hydraulic	Upland	
Channel to Newport News	VA	114,352	.58	66,063	26,013	92,076	M	Corps of Engineers	"Goethals"	Craney Island	
Thimble Shoal Channel		358,960	.70	249,559	32,859	282,418	M	Corps of Engineers	"Goethals"	Ocean Disposal	
Tangier Channel	VA	78,528	.84	66,245	7,924	74,169	M	J.A. Laporte	16" pipeline "Clarendon"	Upland on Western Island in Tangier Island	DACW65-69-C-0026
Totuskey Creek	VA	235,432	.42	98,573	14,783	113,356	M	J.A. Laporte	16" pipeline "Clarendon"	Upland on the banks of Totuskey Creek	DACW65-69-C-0026

TABLE A-13

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1971

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Waterway on the Coast of VA	VA	102,440	0.81	82,976	12,049	95,025	M	Cottrell Eng. Co.	12" pipeline "Marion"	Upland	DACW65-70-C-0066
Norfolk Harbor in the vicinity of the Navy Degaussing Range	VA	172,739 109,472 282,211	0.99 0.58	170,493 63,494 233,987	10,000	243,987	M	Norfolk Dredging Co.	22" pipeline "Pullen" 18" pipeline dredge "Talcott"	Craney Island	DACW65-70-C-0069
Starling Creek Accomack County, Saxis	VA	23,682		subcontract		65,600	M	Wroten Dredging Co.	10" pipeline dredge "Capt Dale"	Upland on Saxis Island	DACW65-70-C-0072
Richmond Harbor, Richmond Deep-water Terminal & Shoals below Hopewell	VA	77,960 41,974 35,205 913,739 107,427 1,176,305	0.806 0.801 0.796 0.292 0.287	62,836 33,621 28,023 266,812 30,832 422,124	19,914	442,038	M	Atkinson Dredging Co.	18" pipeline "Enterprise"	Upland on banks of James River	DACW65-70-C-0065
Long Creek to Broad Bay & Part of Basin, Lynnhaven Inlet	VA	28,133	0.84	23,632	25,000	48,632	M	Higgerson-Bachanan Inc.	14" pipeline dredge "Virginia Beach"	Upland along the shore by mooring and turning basin	DACW65-70-C-0061
Entrance to Channel & Basin, Lynnhaven Inlet	VA	10,832 103,554 114,586	1.15 0.84	12,457 86,985 99,442	included 23.	99,465	M N	Atkinson Dredging Co.	16" pipeline "Northwood II"	upland along the shore. Upland by mooring & turning basin	DACW65-70-C-0061
Sewells Point Anchorage, Norfolk Harbor, East and West Anchorage	VA	8,968,092	0.42	3,766,599	60,000	3,826,599	M N	Great Lakes Dredge and Dock Co.	27" pipeline dredge "Alaska Idler" and booster	Craney Island	DACW65-71-C-0002
Norfolk Harbor 45' ft channel	VA	1,167,133 78,336 1,245,469	0.55 0.50	636,087 39,168 675,255	7,949 94 8,043	683,298	M	Atkinson Dredging Co.	18" pipeline dredge "Enterprise"	Carney Island	DACW65-71-C-0020
Davis Creek Mathews County	VA	45,367	0.74	32,572	12,012 17	45,601	M	Cottrell Engineering Co.	12" pipeline dredge "Marion"	Upland on Bayside and adjacent open water	DACW65-71-C-0032
Oyster Channel Northampton County	VA	41,954	0.74	31,046	11,088 32 11,120	42,166	M N	Cottrell Engineering Co.	12" pipeline dredge "Marion"	Upland	DACW65-71-C-0032
Channel to Newport News	VA	295,100		294,065	58,769	352,834	M	Corps of Engineers	"Goethals"	Craney Island	

TABLE A-14

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1972

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Lower North Landing River	VA	337,911	0.305	103,063	5,000	108,080	M	Merritt Dredging Co.	18" pipeline dredge "Clinton"	Open water in North Landing River in designated spoil areas	DACW65-72-C-0019
Lewis Creek & Chincoteague Bay	VA	25,645	1.052	26,979	included	26,979	M	Spickard Enterprise Inc.	12" pipeline dredge "Black Duck"	Open water Chincoteague Bay along banks of channel	DACW65-72-C-0018
Greevale Creek	VA	22,677	0.80	18,142	10,790	28,944	M N	Cottrell Engineering Corp.	12" pipeline dredge "Marion"	In open water in Rappanhanock River, close to project	DACW65-72-C-0033
Hoskins Creek	VA	127,192	0.495	62,960	13,000 19 13,019	75,979	M	Norfolk Predging Co.	18" pipeline dredge "Stuart"	Upland on tip of Hoskins Creek	DACW65-72-C-0039
Chesapeake Bay to Magothy Bay, Northhampton County	VA	58,840	1.052	61,900	included 20	61,919	M N	Spickard Enterprise Inc.	12" pipeline dredge "Marion"	Upland on edges of Fisherman's Island	DACW65-72-C-0018
Tylers Beach, Isle of Wright County	VA	29,363	0.89	26,133	7,391 12 7.403	33,536	M	Cottrell Engineering Corp.	12" pipeline dredge "Marion"	Upland on the beach	DACW65-72-C-0048
Deep Creek Canal Atlantic Intercoastal Waterway, Chesapeake	VA	105,525	0.87	91,807	18,900	110,707	M N	Cottrell Engineering Corp.	12" pipeline dredge "Blue Ridge"	Upland on bank of Deep Creek Waterway	DACW65-71-C-0050
Richmond Harbor Deepwater Terminal & Shoals above & below Hopewell	VA	422,942 770,364 1,193,306	0.542 0.320	229,235 246,516 475,751mod.	15,000 152 4,550 19,702	495,453	M	Merritt Dredging Co.	18" pipeline dredge "Clinton"	Open water into James River	DACW65-71-0059
Appomattox River Small boat harbor to Long Island	VA	36,011	1.06	38,177	19,500	57,672	M	Cottrell Engineering Corp.	12" pipeline dredge "Blue Ridge"	Upland east of Fort Lee Military Reservation on River Bank	DACW65-71-C-0061
Greenvale Creek Lancaster County	VA	11,435	NA	9,735	3,000	12,735	N	Wroten Dredging Co.	10" pipeline dredge "Capt. Dale"	open water in Rappahannock River, close to project	DACW65-72-C-0004
Dredging Waterway on the coast of Va. Little Machipongo River & Wishart Point Channel	VA	218,407	1.052	229,764	54,800	284,564 mod. 188,898 373,462	M N	Spickard Enterprise	12" pipeline dredge "Raritan"	Open water into Hog Island bay and upland along Machipongo River Wishart Point. Upland	DACW65-72-C-0018
Norfolk Harbor	VA	1,196,300		589,644	repairs 3,516 23,972 27,488	617,132	M	Corps of Engineers	"Goethals"	Craney Island	
Cape Henry	VA	369,178		378,183	maint. engineering 86,669 surveys 13,096 99,765	447,948	M	Corps of Engineers	"Essayons"	Open water 8 miles south of Cape Henry Channel	
Newport News Anchorage, Newport News	VA	3,814,194	0.83	3,165,781	65,000	3,230,781	N	Great Lakes Dredge & Dock Co.	27" pipeline dredge "Alaska"	Craney Island	DACW65-71-C-[illegible]

TABLE A-15

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1973

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Rehandling Basin Disposal area for Norfolk Harbor & adjacent waters	VA	845,287	0.53	448,002	10,000 41 10,041	458,043	M N	Norfolk Dredging Co.	18" pipeline dredge "Talcott" & "Stuart"	Craney Island	DACW65-72-C-0064
Quinby Creek, Accomack County	VA	107,352	0.74	79,441	21,400 54 21,454	100,894	M	Cottrell Engineering Co.	12" pipeline dredge "Marion"	Open water along coast, west of channel	DACW65-73-C-0101
Tangier Channel, Accomack County	VA	81,622	0.86	70,195	16,000 24 16,024	86,219	M N	Cottrell Engineering Co.	12" pipeline dredge "Marion"	Upland on western island in Tangier Island	DACW65-72-C-0072
Lynnhaven Inlet Bay and Connecting Waters, Va. Beach	VA	94,556	1.03	97,393	40,000 20 40,020	137,412	M N	Cottrell Engineering Co.	12" pipeline dredge "Marion"	Upland on mooring and turning basin	DACW65-72-C-0072
Norfolk Harbor 45' ft channel	VA	400,084 38,733 438,817	0.673 0.54	269,257 20,916 290,173	1,265 23 1,288	291,414	M N	Norfolk Dredging Co.	18" pipeline dredge "Talcott"	Craney Island	DACW65-73-C-0052
Deepwater Terminal & Shoals below Hopewell, James River	VA	66,009 1,115,031 1,181,040	0.975 0.415	64,359 462,738 527,097	44,500 Mod 1: Levee repair 7,875 66 52,441	579,538	M N	Atkinson Dredging Co.	18" pipeline dredge "Enterprise"	Upland along banks and open water in James River	DACW65-72-C-0071
Dismal Swamp Canal & Feeder Ditch	VA	24,304	1.38	33,540	8,000	41,540	M N	Cottrell Engineering Corp.	12" pipeline dredge "Marion"	Upland into [illegible]	DACW54-72-C-0076
Waterway on coast of VA & Chincoteague Bay Channel	VA	409,306	1.075	440,004	54,075 mod: 23,800	517,879	M	Spickard Enterprise Inc.	12" pipeline dredge "Raritan"	Open water along the coast	
York Spit Channel	VA	532,100	.93	495,630	9,678	505,308 maintenance engrng.	M	Corps of Engineers	"Essayons"	Open water in Chesapeake Bay northeast of York Spit Channel	
Norfolk Harbor	VA	576,760	.63	364,641	97,890 bulkhead repairs	462,531	M	Corps of Engineers	"Goethals"	Craney Island	
Channel to Newport News	VA	207,800	1.20	249,506	53,614	303,120	M	Corps of Engineers	"Goethals"	Craney Island	
Thimble Shoal	VA	789,635	.90	710,672		710,672		Corps of Engineers	"Goethals"	Open water 8 miles south of Cape Henry	
Craney Island Rehandling Basin	VA	845,287						Norfolk Dredging Company	12" pipeline "Virginian"	Craney Island	

TABLE A-16

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1974

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	S or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Norfolk Harbor Metomkin Bay, Waterway on Coast of Va.	VA	57,575 18,557 76,132					M	Spickard Enterp. Inc.	12" pipeline dredge "Raritan"	Open water	DACW65-73-C-0085
Waterway on Cost of Va. Chincoteague Parker Creek	VA	17,000 50,771 180,678 37,012 285,461	1.05 0.93 1.09 1.65	17,850 47,217 196,939 61,070 1,000 324,076	109,080 54 109,134	433,156	M	Cottrell Eng. Corp.	12" pipeline dredge "Marion"	Upland Parker Creek and open water	DACW65-74-C-0028
Waterway on Coast of Va.	VA	232,054	1.09	252,938	88,020 54 88,074	341,012	M	Cottrell Eng. Corp.	12" pipeline dredge "Richmond"	Upland	DACW65-74-C-0023
Starlings Creek	VA	48,724	1.35	65,777	44,700 15 44,715	110,492	M	Cottrell Eng. Corp.	12" pipeline dredge "Marion"	Upland on Saxis Island	DACW65-74-0053
Tangier Channel	VA	81,139	1.10	89,253	25,356 34 25,390	114,643	M	Cottrell Eng. Corp.	12" pipeline "Marion"	Upland on western Island in Tangier Sound	DACW65-74-0052
Hampton Creek and Approach Channel	VA	26,324	1.80	47,383	5,000 9 5,009	52,392	M S	Norfolk Dredging Co.	12" cu. yd. bucket "Virginian"	Craney Island & Rehandling Basin	DACW65-73-C-0018
Richmond Harbor Richmond Deepwater Ter. to Hopewell & City Point Shoal Channel	VA	688,761	0.93 0.74 0.435	586,793	mod 1: 50,000	636,061	M	Atkinson Dredging Co.	16" pipeline dredge "Northwood"	Openwater into James River	DACW65-73-C-0090
Norfolk Harbor	VA	372,147					M	Corps of Engineers	"Goethals"	Craney Island	
Southern Branch	VA	621,804		598,033		598,033	M	Corps of Engineers	"Goethals"	Craney Island	
Cape Henry Channel	VA	105,346		87,291	17,599	104,890	M	Corps of Engineers	"Goethals" "Essayons"	Open water in north of Chesapeake Bay East York Spit Channel	
Smith Creek	VA	37,062	5.47	202,729	26,000	228,779	M	Thomas Crooks, Jr.	3 yd^3 bucket dredge #709	Craney Island	

TABLE A-17

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1975

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Norfolk 45' Project	VA	491,372	0.783	384,744	29,000	413,744	M N	Atkinson Dredging Co.	22" pipeline dredge "Pullen"	Craney Island	DACW65-75-C-0023
Norfolk 45' Project	VA	68,100 726,551 794,651	0.72	49,032 568,889 617,921	29,000 26 29,026	646,947	M N	Atkinson Dredging Co.	18" pipeline dredge "Enterprise"	Craney Island	DACW65-75-C-0023
North Channel	VA	99,194	0.895	88,779	52,000	140,779	M N	Cottrell Eng. Co.	12" pipeline dredge "Marion"	Open water Hog Island Bay	DACW65-75-C-0036
Southern Branch of Elizabeth River	VA	211,549	1.64	346,940	19,900	366,840	M N	Norfolk Dredging Co.	22" pipeline dredge "Pullen"	Upland on river bank	DACW65-74-C-0070
Richmond Deep-water Terminal to Shoals below Hopewell, Va.	VA	1,022,209			95,000 levee work: 14,300 turbidity barriers: 65,000 dredge rental 5 days:40,000 214,300		M N	Merrit Dredging Co.	18" pipeline dredge "Clinton"	Upland on James River banks	DACW65-74-C-0075
Aberdeen Creek Gloucester County	VA	50,426	1.22	61,520	59,104	120,624	M	Atkinson Dredging Co.	16" pipeline dredge "Northwood II"	Upland bank of York River	DACW65-74-C-0073
Skiffes Creek Ft. Eustis	VA	263,962	0.947	249,972	65,000 area prep. 75,014	389,986	M N	Atkinson Dredging Co.	16" pipeline dredge "Northwood II"	Upland on Ft. Eustis	
Channel to Newport News	VA	97,253		130,355	1,082 administration	131,451	M	Corps of Engineers	"Goethals"	Craney Island	
Thimble Shoal	VA	1,129,143		1,614,627	maintn. engn. and Administration	1,614,627	M	Corps of Engineers	"Geothals"	Open water 8 miles south of Cape Henry Channel	

TABLE A-18

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1976

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Richmond Harbor Deepwater Terminal Jordan Point James River	VA	94,409 221,134 215,285 530,828	1.12 0.655 0.632	105,738 144,843 136,060 386,641	73,500 turbidity barriers 5,200 meals 68 mod1:10,125 mod2: 8,675	484,209	M	Atkinson Dredging Co.	16" pipeline dredge, 18" pipeline dredge "Northwood II" "Enterprise"	Upland on James River Bank	W-65-76-C-0017
Norfolk Harbor	VA	372,352	0.98	364,905	2,000 meals 29 liquidated damages: 1,650 3,679	365,284	M N	Norfolk Dredging Co.	18" pipeline "Talcott" dredge	Craney Island	DACW-65-76-C-0013
Gull Marsh (Waterway on the Coast of Va.) North-hampton County	VA	170,971	1.04	177,810	27,145 855 (lodging) 28,000	205,810	M N	K.P. and B Dredging Co.	14" pipeline dredge "Jamie III" and "Patty"	Upland on adjacent marsh flats	DACW-65-76-C-0021
Jarvis Creek, Northumberland County	VA	22,398	1.00	22,398	44,400 meals 23 44,423	68,821	N	Cottrell Eng.. Corp.	12" pipeline dredge "Richmond"	Upland	DACW-65-76-C-0037
Norfolk Harbor 45' Channel	VA	759,188 1,004,809	0.922 0.725	695,059 728,487	2,000	697,059 730,436	N M N M	Norfolk Dredging Co.	22" pipeline dredge "Pullen" 18" pipeline dredge "Enterprise"	Craney Island	DACW-65-76-C-0041
Chincoteague Inlet	VA	69,390		117,900	engineering maintenance 66,027	183,927	M	Corp of Engineers	"Fry" Sidecaster	Overboard next to channel	

TABLE A-19

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1977

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Lynnhaven Inlet	VA	94,177	1.67	157,276	50,000	207,996	M	Norfolk Dredging Co.	16" pipeline dredge #44	Upland	DACW-65-77-C-0014
Waterway on the Coast of Va. Bradford Bay	VA	67,505	0.90	60,755	67,452	128,207	M	Cottrell Engn. Corp	12" pipeline dredge "Richmond"	Overboard	DACW-65-77-C-0013
Quinby Creek Eastern Shore	VA	85,585	1.65	141,215	50,000 turbidity barrier 50,000 meals 80 100,080	241,295	M	Cottrell Engn. Corp	12" pipeline dredge "Marion"	Upland & overboard	DACW-65-77-C-0024
Norfolk Harbor 45' Sewells Point Anchorage	VA	550,116	0.95	522,610	28,000	550,610	M	Norfolk Dredging Co.	22" pipeline dredge "Pullen"	Craney Island	DACW-65-77-C-0025
Waterway on the Coast of Virginia, Fisherman's Island	VA	23,195	1.84	42,679	21,000 lodg 50 21,050	63,629	M	Norfolk Dredging Co.	16" pipeline dredge #44	Along the beach at bridge	DACW-65-77-C-0044
York Spit Channel	VA	216,359		538,993	engn design and adm 61,411	600,404		Corps of Engineers	"Goethals"	Open water in Chesapeake Bay, North coast of channel	
Deep Creek, Newport News	VA	42,864						Corps of Engineers	Bucket	Craney Island disposal site	

TABLE A-20

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1978

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Craney Island Rehandling Basin	VA	1,168,933	0.79	923,457	7,300	930,809	M	Norfolk Dredging Co.	18" pipeline dredge "Talcott"	Craney Island	DACW-65-78-C-0010
Tangier Channel Accomack County	VA	86,416	1.80	115,549	60,400 disp area prep. 86,416 146,816	331,182	M	Cottrell Engn. Corp.	12" pipeline dredge "Richmond"	Upland next to runway	DACW-65-77-C-0039
White Trout Creek Swash Bay, Bogues Bay Northam Narrows	VA	160,200	1.16	185,832	61,000	246,832	M N	Cottrell Engn. Corp.	12" pipeline dredge "Blue Ridge"	3 areas upland 1 overboard	DACW-65-77-C-0051
Magothy Bay, Sloop Channel, Burton's Bay	VA	291,075	1.16	337,647	60,000 meals 176 turb barriers 54,000 114,176	451,823	M	Cottrell Engn. Corp.	12" pipeline dredge "Marion"	Beside marsh	DACW-65-77-C-0051
Western Branch of Nansemond River	VA	52,342	1.06	55,483	63,200 18 63,218	118,701	M N	Atkinson Dredging Co.	16" pipeline dredge "Northwood II"	Upland	DACW-65-77-C-0048
Dismal Swamp Canal	VA	34,933	1.72	60,085	6,000	66,085	M	Liles Supermarine	10" pipeline dredge "Surprise"	Upland into ~~swamp~~	DACW-65-78-C-0013
Mooring Area West of Great Bridge Lock	VA	9,562	2.93	28,017	5,200	33,217	N	Norfolk Dredging Co.	3 yd^3 #428 bucket dredge	Craney Island	DACW-65-78-C-0027
Greenvale Creek Lancaster County	VA	15,797	1.90	30,014	49,482	79,497	M	Liles Supermarine	10" pipeline dredge "Surprise"	Upland next to Creek	
Craney Island Rehandling Basin	VA	64,944	0.79	51,306		51,306	M	Norfolk Dredging Co.	22" pipeline dredge "Pullen"	Craney Island	DACW-65-78-C-0010
Deep Creek Newsport News	VA	27,998 5,424 33,422	7.24	202,706 39,270 241,976	24,800	266,776	M	Norfolk Dredging Co.	5 yd^3 bucket dredge "Perry"	Craney Island	DACW-65-77-C-0030
Richmond Harbor & Deepwater James River	VA	86,230 79,273	1.52 1.02	131,070 80,859	108,900 120	320,949	M N	Atkinson Dredging Co.	16" pipeline dredge "Northwood II"	City owned upland	DACW-65-77-C-0045
Norfolk Harbor 45' Channel	VA	318,825 338,740 657,565	1.24 0.94	395,343 318,416 713,759	18,500	732,259	M	Norfolk Dredging Co.	22" pipeline dredge "Pullen"	Craney Island	DACW-65-78-C-0023

TABLE A-21

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1979

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Queens Creek Mathews County	VA	10,951	1.45	15,879	34,000	49,879	M	Northampton Dredge Co./ Wroten Dredging	10" pipeline dredge "Dixie"	Upland	DACW65-79-C-0018
Winter Harbor Mathews County	VA	3,800 36,626 40,426	1.60	6,080 58,602 64,682	51,000	115,682	M N	Northampton Dredging Co.	10" pipeline dredge "Dixie" 10" pipeline dredge "Manna"	Upland	DACW65-79-C-0018
Starlings Creek Saxis, Accomack County	VA	57,200	1.75	100,000	46,800	146,900	M	Northampton Dredging Co.	10" pipeline dredge "Manna"	Upland north of creek	DACW65-79-C-0026
Skiffes Creek Ft. Eustis	VA	143,747	1.78	255,870	110,374 Disp. Area Prep. 196,000 306,374	562,244	M	Cottrell Engn. Co.	12" pipeline dredge "Marion"	Upland on Ft. Eustis	DACW65-79-C-0022
Seaways Pier Area Town Point Beach, Norfolk Harbor	VA	13,644	2.63	35,884	9,400	45,284	M	Norfolk Dredging Co.	4 yd^3 bucket dr. #428	Craney Island	DACW65-79-C-0019
Norfolk Harbor 45' Channel	VA	422,359 450,284 872,643	1.24 0.94	523,725 423,267 946,992	18,540	965,532	M N	Norfolk Dredging Co.	18" pipeline dredge "Talcott"	Craney Island	DACW65-78-C-0023

TABLE A-22

DREDGING STATISTICS FOR FEDERAL PROJECTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1980

Project Name	State	Amount of Material Dredged (Cu. Yd)	Cost Per Unit ($)	Cost of Acutal Dredging ($)	Cost of Mobilization Demobilization and Other ($)	Total Cost ($)	N or M	Contractor or COE	Method Used For Dredging	Disposal Site	Contract Number
Deep Creek Channel, Newport News	VA	28,157	5.20	146,416	15,000 turbidity barriers 42,000 57,000	203,416	M	Norfolk Dredging Co.	bucket dredge #111	Craney Island	DACW-65-80-C-0001
Channel Newport News	VA	148,466	5.20	772,023	15,000	787,023	M		#428		
Deep Creek Chanel Newport News	VA	79,352	5.20	412,630		412,630	M	Rose Marine of Va., Inc.	# 27	Craney Island	DACW-65-80-C-0001
Southern Branch of Elizabeth River	VA	1,439,912	1.33	1,915,083	46,840 other: 30,179 77,019	1,992,102	N	Norfolk Dredging Co.	18" pipeline dredge "Talcott"	Craney Island	DACW-65-79-C-0031
		1,709,68[illegible]	1.33	2,273,881	46,840 144 46,984	2,320,865	N		22" pipeline dredge "Pullen"	Craney Island	
		222,563	1.33	296,009	36	296,045	N		12" pipeline dredge "Essex"	Craney Island	
Back River, Langley Field	VA	54,703	1.96	107,218	74,954 turb barriers 74,438 149,438	256,656	M	Cottrell Engn. Co.	12" pipeline dredge "Marion"	Upland next to river	DACW-65-79-C-0059
Dismal Swamp Canal	VA	68,630	1.34	91,964	54,000 36 54,036	146,000	M	Cottrell Engn. Co.	12" pipeline dredge "Marion"	Upland next to canal	DACW-65-79-C-0047
East & West Anchorages, Norfolk Harbor	VA	829,406	0.96	796,230	99,250	895,480	M	Atkinson Dredging Co.	18" pipeline dredge "Enterprise"	Craney Island	DACW-65-79-C-0034
West Anchorages Norfolk Harbor	VA	472,000	0.96	453,120	99,250	552,370	M	Atkinson Dredging Co.	18" pipeline dredge "Hampton Roads"	Craney Island	DACW-65-79-C-0034
Norfolk Harbor	VA	753,084	1.12	843,454	57,000 80 57,080	900,534	M	Atkinson Dredging Co.	18" pipeline dredge "Hampton Roads"	Craney island	DACW-65-79-C-0037
		768,299	1.12	860,495	57,000 80 57,080	917,575	M		18" pipeline dredge "Enterprise"	Craney Island	DACW-65-79-C-0037
Newport News Anchorage Hampton Rds.	VA	967,382	1.39	1,344,661	135,000	1,479,661	M	Norfolk Dredging Co.	22" pipeline dredge "Pullen"	Craney Island	DACW-65-80-C-0018
Tangier East Channel Tangier Island	VA	52,698	2.94	154,932	54,000 100 54,100	209,032	N	Cottrell Engn. Co.	12" pipeline dredge "Richmond"	Upland on island	DACW-65-80-C-0027
Rehandling Basin	VA	1,300,000		credited by user's tolls				Norfolk Dredging Co.	18" pipeline "Talcott"	Craney Island	DACW-65-80-C-0020
Chincoteague Inelt	VA	79,834	4.02	302,152	113,962	435,114	M	Corps of Engineers	"Fry"	Next to channel	
Deep Creek AIW Chesapeake	VA	4,694	3.88	18,213	1,800	20,013	M	Norfolk Dredging Co.	8 yd^3 bucket #428	Craney Island	DACW-65-79-C-0020

TABLE A-23

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1975

Date	Permittee	Location	Total Amount Dredged	N M	Method Used For Dredging	Disposal Site	File Number
3/16/76	Mr. W.G. Brooks Holliday Marina	Elizabeth River, Va.	3,000	M	dragline	Craney Island Rehandling Basin	0029
5/7/76	City of Norfolk	Elizabeth River, Va.	2,300	M	bucket	city's sanitary landfill	2735
2/19/76	City of Portsmouth	Southern Branch of Elizabeth River, Va.	18,750	N		-Craney Island Rehandling Basin -some behind bulkhead	0023
3/9/76	VA Department of Highways and Transportation	Western Branch of Elizabeth River, Va.	8,400	N	bucket	to Craney Island Rehandling basin	0027
4/16/76	David Stormont	Great Neck Creek, Va.	275	M	bucket	on top of riprap	0839
5/21/76	Robert L. Denig	Great Neck Creek, Va.	100	N	bucket	behind bulkhead	2500
8/16/76	Mobjack Bay Marina	Green Mansion Cove, Va.	130	N	bucket	upland behind earthen berm	2588
6/28/76	VA Department of Highways and Transportation	Giucatic Creek	701	N	dragline	within road prism or in upland area	2663
9/3/76	Bluewater Yacht Sales	Hampton Creek, Va.	8,000	N	bucket	barged to Craney Island Rehandling Basin	2506
1/13/75	United States Gypsum Co.	Southern Branch of Elizabeth River, Va.	3,750	N	clamshell	Craney Island Disposal Area	2045
3/11/75	Yellow River, Ldt.	Southern Branch of Elizabeth River, Va.	11,782	N	bucket	Craney Island disposal area	2154
5/30/75	Lone Star Industries	Southern Branch of Elizabeth River, Va.	8,800	N	bucket	Craney Island Rehandling basin	2269
8/14/75	Norfolk Shipbuilding and Drydock Co.	Southern Branch for Elizabeth River, Va.	20,000	M	bucket	upland	2309
8/25/75	Swann Chesapeake Terminal Corp.	Southern Branch of Elizabeth River, Va.	125,000	N	hydraulic and bucket	Craney Island disposal area	2264
4/30/75	Naval Facilities Engineering Command	Hampton Roads, Va.	540,000	N	hydraulic	Craney Island disposal area	2178
5/28/75	City of Newport News	Hampton Roads, Va.	500	M	hydraulic	upland, confined behind earthen berm	2258
5/5/75	Mr. William J. Godsey	Horn Harbor	360	M	bucket		1898
8/12/74	Chesapeake and Ohio Railway Co.	James River, Va.	40,000	M		Craney Island rehandling basin	1821
3/3/75	East Cove Waterway Association	Broad Bay, Va.	1,900	N	dragline and/or hydraulic	upland, confined behind earthen berm	2022
4/2/75	Gwynn Island Estates Property Owners Assn.	Chesapeake Bay, Va.	681	N		upland, behind existing bulkhead	1799
6/16/75	Russell Fish Company Inc.	Chincoteague Channel and Inlet, Va.	1,200	N	dragline	upland	1798
7/10/75	Mr. Wallace E. Lewis	Cockrell Creek, Va.	400	N	bucket	upland	2183
5/12/75	Corrotoman-By-the-Bay	Corrotoman River, Va.	250	M	bucket	upland	2189
5/9/75	Mr. Robert L. Ewell	Point Drum Creek, Va.	555	N	bucket	upland, confined behind earthen berm	1576
5/21/75	Mr. Howard W. Pulley	Edwards Creek, V[illegible]	615	N	dragline	upland, confined behind earthen berm	1579
1/29/75	Naval Facilities Engineering Command	Elizabeth, River, Norfolk Harbor, Va.	32,100	N	hydraulic	Craney Island disposal area	2149
10/8/75	Cargill, Inc.	Southern Branch of Elizabeth River, Va.	4,000	N	bucket and hydraulic	Craney Island disposal area	1851
2/12/75	Allied Chemical Corp.	James River, Va.	5,000	N			2147
7/31/75	Dock Iron and Metal Co., Inc.	James River, Va.	30,000	N	dragline		2281
4/2/75	City of Virginia Beach	Long Creek, Va.	24,000	M	hydraulic	upland, confined behind earthen berm	2217
1/29/75	L.G. Allen R. Carpenter, USN	Lynnhaven River, Va.	300	N	bucket		2019
2/5/75	Mr. Richard Haden	Lynnehaven River, Va.	144	N	bucket		2021
2/5/75	Mr. Eugene G. Schmidt	Lynnehaven River, Va.	180	N			2035

TABLE A-23 (concluded)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1975

Date	Permittee	Location	Total Amount Dredged	N M	Method Used for Dredging	Disposal Site	File Number
3/24/75	Mr. Joe L. Gilbert	Lynnhaven River, Va.	150	M		upland behind existing bulkhead	2012
7/14/75	Mr. Frank J. Wade	Lake Rudee, Va.	216	M	dragline	upland, confined behind bulkhead	2047
2/5/75	Mr. Stephen H. Mundy	Linkhorn Bay, Va.	300				1811
6/2/75	Mr. John E. Canady	Wormley Creek, Va.	130	M	bucket	upland behind bulkhead	1617
5/12/75	V.I.M.S.	York River, Va.	1,500	N	hydraulic or bucket	upland behind new bulkhead	2212
6/5/75	Willoughby Bay Marina	Willoughby Bay, Va.	500	N	bucket or dragline	upland behind bulkhead and confined	2050
10/21/75	Dr. Habib J. Kurani	Wilson Creek, Va.	600	M	bucket	upland beind bulkhead and confined	1151
1/29/75	Va. Commission of Game and Inland Fisheries	Rappahannock River, Va.	5	M			1896
4/25/75	Windwill Point Marina	Rappahannock River, Va.	5,500	N	hydraulic or bucket	upland behind earthen levee	2239
6/30/75	Mr. Charles M. Lewis	Rappahannock River, Va.	120	M	dragline	upland behind earthen berm	1588
4/25/74	Joseph J. Vodvarka	Wachapreague Channel, Va.	850	M	dragline	upland beind bulkhead	2560
1/13/75	Hampton Roads Sanitation District	Warwick River, Va.	18,000	N	bucket	6000 yd^3 at Craney Island Reh. Basin 12000 yd^3 used as backfill	1865
7/24/75	Mr. Fred L. Garrett	Rappahannock River, Va.	1,460	M	dragline	upland behind bulkhead and confined	2211
7/10/75	Barclay Sheaks and Glenn Shepard	Poquoson River, Va.	400	N	dragline	upland behind earthberm	1740
5/5/75	Fishing Bay Marina	Poquoson River, Va.	1,000	M	hydraulic	upland, pumped behind bulkhead	2044
3/24/74	Dow Badische Co.	Skiffers Creek, Va.	75,000	M		upland disposal area, and confined behind earthen berm	1877
8/25/75	Mr. Benjamin F. Whitten	Thalia Creek, Va.	200	N	bucket	upland, behind bulkhead	1600
2/26/75	H.J. Williams	Prentice Creek, Va.	450	N	bucket	upland, behind earthberm	1806
4/19/75	Mrs. & Mr. John R. Frallic	Pungoteague Creek, Va.	270	N	clamshell	upland, behind earthberm	1917
10/2/74	L.H. Thomas	Sarah Creek. Va.	65	N	bucket		1915
3/6/75	Naval Facilities Engineering Command	Little Creek, Va.	500,000	N	hydraulic	beach replenishment 9000 ft of naval amphibious base Little Creek	2138
3/12/75	Naval Facilities	Little Creek, Va.	150,000	M	bucket	Craney Island disposal area	2179
5/21/75	Mr. Donald H. Spitzli, Jr.	Little Creek, Va.	200	M	dragline	upland, confined behind earthen berm	2029
4/2/75	City of Va. Beach	Long Creek, Va.	24,000	M	hydraulic	upland, behind earthen berm	2117
3/24/75	Mr. Robert Harris	Lynnhaven River, Va.	75	M	bucket	upland, behind bulkhead	2032
4/2/75	Msrs. James J. Murphy, Jr., and Maxton M. Midgett	Lynnhaven River, Va.	1,500	N	hydraulic and bucket	upland, behind bulkhead	2004
4/7/75	Mr. C.B. Gifford, Jr.	Lynnhaven River, Va.	170	M	bucket	upland, behind earthen berm	2067
6/19/75	City of Va. Beach	Lynnhaven River, Va.	3,850	M	hydraulic and dragline	upland, behind bulkhead	1765
9/12/75	Msrs. Kenneth W. Duncan & W.M. Gunter	Lynnhaven River, Va.	70	M	dragline		1986
7/1/75	Glouchester Point Marina	Sarah Creek, Va.	700		bucket	upland, and confined behind earthen berm	1891
5/22/75	City of Portsmouth	Scotts Creek, Va.	550		dragline	upland, and confined behind earthen berm	2161
7/16/75	City of Portsmouth	Scotts Creek, Va.	20		dragline	City of Portsmouth landfill	2279
7/24/75	S.L. Williamson Co., Inc.	Rivanna River, Va.			hydraulic	for commercial use	1730
4/2/75	Mr. & Mrs. Sherman T. Holmes	Robinson Creek, Va.	163		hydraulic	upland and behind earthen berm	3302
3/3/74	City of Colonial Heights	Appotamox River, Va.	445	N	bucket	upland disposal city property	1820
8/13/74	Chincoteague Nat. Wildlife Refuge	Tom's Cove, Va.	11,000	M	dragline		1489

N = new work
M = maintenance

TABLE A-24

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1976

Date	Permittee	Location	Total Amount Dredged	N M	Method Used For Dredging	Disposal Site	File Number
8/20/75	Horne Brothers, Inc.	James River, VA	8,900	N	clamshell	Craney Island Rehandling Basin	2347
8/6/75	Mr. James T. Spratley	Blackwater Creek	100	N	dragline	temporarily behind boat house	2246
9/15/76	Norfolk Dredging Co.	Albemarle and Chesapeake Canal VA	88,000	N	hydraulic	upland, confined behind an earthen berm	2754
1/26/76	Cedar Park Co.	Back River Southwest Branch, VA	13,330	N	dragline	upland, confined behind bulkhead	1863
8/11/75	City of Virginia Beach, Municipal Center	Broad Bay, VA	21,500	M	hydraulic	upland, behind earthen berm	2157
10/1/75	Mr. Raymond V. Smith, Jr.	Broad Creek, VA	65	N	dragline	upland behind earthen berm	1962
1/27/76	Mr. Eugene Duffer	Browns Creek, VA	175	N	dragline	upland	2488
7/26/75	Mssrs. J.C. Morris and W. Dan	Brooks Cove, VA	900	N	dragline		2030
8/6/75	Virginia Port Authority	Elizabeth River	28,000	M	hydraulic	Craney Island Disposal area	2321
9/27/76	J.S. Darling & Son	Hampton Creek	50	N		adjacent upland area	3023
6/29/76	Naval Facilities Engineering	Hampton Roads, VA	603,000	N	hydraulic	Craney Island Disposal area	2683
5/3/76	VA Dept of Highways and Transportation	Western Branch of Elizabeth River, VA	26,000	N	bucket	Craney Island Rehandling Basin	2614
6/11/76	Joseph Salanga	Western Branch of Elizabeth River, VA	15	N	bucket	behind bulkhead	1701
8/2/76	Craig C. Barkley	Western Branch of Elizabeth River, VA	1,250	N	bucket	behind bulkhead	2702
8/17/76	Donald C. Meeking	Western Branch of Elizabeth River, VA	150	N	dragline	behind bulkhead	2435
6/14/76	Lone Star Industries, Inc.	James River, VA	30,000	M	hydraulic	pumped into an abandoned water filled borrow pit	2294
6/11/76	Brown Boveri Power Equip. Inc.	James River, VA	2,400	M	bucket	upland area and confined behind an earthen berm	2401
7/16/76	Newport News Shipbuilding	James River, VA	250,000	M	bucket	Craney Island Rehandling Basin	2349
5/21/76	City of Portsmouth	Scotts Creek, VA	2,230	N	dragline	upland, confined behind earthen berm	2613
5/2/76	Katherine H. Donaldson	Mosquito Creek, VA	2,000	M	dragline	upland on adjacent upland peninsula and confined	2557
3/15/76	Piankatank Shores Civic Association	Piankatank River, VA	200	M	dragline	beach replenishment	2582
6/2/76	Thomas L. Kriete, Jr.	Rappahannock River, VA	1,800	N	dragline	upland behind earthen berm	2635
6/2/76	Charles E. Aigner, Jr.	Wachapreague River, VA	500	N	dragline	upland behind bulkhead	2560
6/4/76	VA Dept. of Highways and Transportation	Wayne Creek, VA	550	N	dragline	City of Norfolk's landfill	2718
7/22/76	VA Dept. of Highways and Transportation	Wolfnare Creek, VA	13,000	N	dragline	upland on adjacent fill later to be removed and disposed of upland	2623
9/10/76	US Coast Guard Training Center	Wormley Creek, VA	4,000	M	hydraulic	upland behind bermed disposal area	2712
6/24/76	Mr. Bunting's Oyster House	York River, VA	250	N	bucket	upland behind existing bulkhead	1959
6/11/76	Sherrill C. Steed	Chisman Creek, VA	50	N	bucket	upland disposal area	2699
3/5/76	Mr. E.S. Bowis	Cockrell Creek, VA	250	N	bucket	upland behind bulkhead	2455
1/12/76	City of Hampton	Cooper Creek, VA	18,000	M	dragline	trucked to a bermed area	2952
4/21/76	VA Dept. of Highways and Transportation	College Creek, VA	1,300	N		upland disposal site	2555
11/26/75	Mr. George W. Hopkins	Cranes Creek	3,000	N	bucket	upland bermed area	2417
10/14/76	Mr. Don J. Leonard	Oyster Bay	85	N	dragline	upland, confined behind earthen berm	2629
9/16/76	City of Portsmouth	Paradise Creek	100	N	clamshell	upland upper reaches of project and confined	2868

TABLE A-24 (concluded)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1976

Date	Permittee	Location	Total Amount Dredged	N M	Method Used For Dredging	Disposal Site	File Number
8/2/76	American Original Food	Parting Creek	1,900	N	dragline	upland disposal area	2667
9/15/76	Harvey B. Heath	Sturgeon Creek	110	N	dragline	disposed of behind earthen berm	2603
9/21/76	VA Department of Highways	Lake Rudee, VA	264	N	dragline	upland within roadway prism	2719
9/3/76	Coastline Properties	Lake Rudee, VA	125	N		upland behind bulkhead	2125
5/28/76	Roger C. Gray	Lake Rudee, VA	50	N	dragline	upland behind existing bulkhead	2659
5/10/76	Thomas L. Thornton	Lilly Creek, VA	50	N	dragline	upland behind existing bulkhead	2551
9/16/75	The Honorable J. Calvitt Clarke, Jr.	Linkhorn, VA	300	N	dragline	upland behind earthen berm	2396
8/6/75	Mr. Jessee Franklin Jackson III	Long Creek, VA	295	N	dragline	upland behind bulkhead	2097
5/4/76	Henry Braithwaite	Long Creek, VA	1,310	N	bucket	behind the bulkhead	2421
10/6/75	Mr. Wilton Holmgren	Lynnhaven River, VA	285	N	dragline	confined behind a bulkhead	2283
1/26/76	Mr. C.H. Butler	Bush Park Creek, VA	3,500	M	dragline	upland	2477

TABLE A-25

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1977

Date	Permittee	Location	Total Amount Dredged	N M	Method Used For Dredging	Disposal Site	File Number
10/15/76	Lone Star Industries	Southern Branch of Elizabeth River, VA	8,100	M	bucket	Craney Island Disposal site and Rehandling Basin	2881
12/17/76	Naval Facilities Engineering Command	Southern Branch of Elizabeth River, VA	85,500	M	bucket	Craney Island Rehandling Basin or Disposal Site	2889
12/17/77	Naval Facilities Engineering Command	Southern Branch of Elizabeth River, VA	50,000	M	bucket	Craney Island Rehandling Basin or Disposal Site	2890
12/17/76	Naval Facilities Engineering Command	Southern Branch of Elizabeth River, VA	85,000	M	bucket	Craney Island Rehandling Basin or Disposal Site	2891
6/8/77	Elizabeth River Terminals, Inc.	Southern Branch of Elizabeth River, VA	7,500	M	bucket	Craney Island Rehandling Basin	3200
7/29/77	Amerada Hess Corp.	Southern Branch of Elizabeth River, VA	90,000	N	bucket	Craney Island Rehandling Basin	2986
8/22/77	Tidewater Equipment	Southern Branch of Elizabeth River, VA	600	M	clamshell	hauled to existing upland disposal area	3436
3/28/77	Leonard T. Golden and Ira D. Hinton	Great Wicomico River, VA	275	N	bucket	upland, behind retaining wall	2525
9/26/77	Ralph F. Rose	Great Wicomino River, VA.	300	N	dragline	upland, behind retaining wall	3382
2/10/77	William F. Cox	Little Neck Creek, VA	500	M	bucket	upland behind existing bulkhead	2998
11/17/76	Charles Robinson	Lynnhaven River, VA	150	M	bucket/ dragline	upland behind existing bulkhead	2946
4/1/77	George S. Langley	Lynnhaven River, VA	267	N	bucket	upland to adjacent disposal area	3087
10/13/76	VA Dept. of Highways and Transportation	Western Branch of Elizabeth River, VA	3,700	N	clamshell or bucket	Craney Island Disposal area	2700
8/31/77	Associated Naval Facilities Architects	Western Branch of Elizabeth River, VA	177	N	bucket	material used within roadway prism	3084
4/8/77	Cutty Sark Marina	Fisherman's Cove, VA	40	N	dragline	upland	3084
4/18/77	Charles W. Mitchell	Fleets Bay, VA	35	N			3041
2/15/77	Atwell J. Booth	Great Wicomico River, VA	225	M	bucket	upland, 2 miles north of project	2953
2/3/77	A. Jackson Booth	Great Wicomico River, VA	385	N	bucket	upland, behind proposed bulkhead	2327
10/13/76	Clyde W. Hudgins	Davis Creek, VA	2,400	N	dragline	confined behind earthen berm	2793
12/30/76	VA Port Authority	Elizabeth River Norfolk Harbor, VA	557,000	N	hydraulic	pumped into Craney Island disposal area	3054
3/25/77	Naval Facilities Engineering Command	Elizabeth River Norfolk Harbor, VA	300,000	M	hydraulic	pumped into Craney Island disposal area	2887
3/25/77	Naval Facilities Engineering Command	Elizabeth River Norfolk Harbor, VA	50,000	M	hydraulic	Craney Island disposal area	2888
12/10/76	City of Norfolk	Lafayette River, VA	26,000	N	clamshell	Craney Island Rehandling Basin	2872
5/27/77	VA Dept. of Highways and Transportation	Lafayette River, VA	15,405	N	bucket/or hydraulic	Craney Island Disposal area and Rehandling Basin	3089
6/16/77	Norfolk Yacht and Country Club	Lafayette River	6,000	M	bucket	Craney Island Rehandling Basin	3234
9/12/77	James W. Kelley and Benjamin Conley	Jarvis Creek, VA	2,490	M	dragline	upland and confined behind earthen berm	2086
4/5/77	Thomas L. Hall and Andrew Miller	Lake Rudee, VA	25	N	dragline	upland behind existing bulkhead	2796
1/28/77	William F. Lawson	Bennets Creek, VA	150	N	dragline	upland, behind earthen berm	2714
1/31/77	VA Dept. of Highways and Transportation	Briery Creek, VA	317	N	bucket	upland, within roadway prism	2815
10/4/76	Detlef F. Bowe	Broad Creek, VA	250	N	dragline	upland behind earthen berm	2713
1/26/77	Shackelford-Schlifer Seafood Corporation	Browns Bay, VA	1,200	N	bucket	upland behind earthen berm	2681
10/22/76	Fort Eutis	Chesapeake Bay, VA	1,000	N	dragline	upland on to adjacent beach	3058
6/2/77	City of Hampton	Chesapeake Bay, VA	92,000	N	hydraulic	upland bermed area some of the sand for beach noruishment	2355

TABLE A-25 (continued)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1977

Date	Permittee	Location	Total Amount Dredged	N M	Method Used For Dredging	Disposal Site	File Number
6/14/77	First Charter Land Corp.	Chincoteague Bay, VA	27,000	N			10D0690
4/4/77	VA Dept. of Highways and Transportation	Craig Creek, VA	337	N	bucket	within roadway prism	3159
10/1/76	Roy E. Folck, Jr.	Crystal Lake, VA	100	M	bucket	upland	2873
2/23/77	Robert T. Farey	Sarah Creek, VA	65	N	hydraulic pump	fill sandbags	2989
3/7/77	VA Dept. of Highways and Transportation	Totopotomy Creek, VA	1,211	N	bucket	contained within roadway prism	3051
10/26/76	VA Dept. of Highways and Transportation	Tye River, VA	1,143	N	bucket	contained within roadway prism	2737
10/1/76	VA Dept. of Highways and Transportation	Nottoway River, VA	180 63 243	N	dragline	within roadway prism	2753
6/23/77	VA Dept. of Highways and Transportation	Nottoway Swamp, VA	88	N	bucket	used within approach ways	3225
6/14/77	VA Dept. of Highways and Transportation	Ogle Creek, VA	226	N	bucket	used within roadway prism	3213
7/14/77	VA Dept. of Highways and Transportation	South Anne River, VA	65	N	bucket	within roadway prism	3295
3/13/77	City of Portsmouth	Paradise Creek, VA	185	N	bucket	upland, confined behind earthen berm	3107
5/4/77	York River Seafood Co.	Perrin River, VA	300	N	dragline	upland, behind bulkhead and contained	3138
3/15/77	William A. Van Sandt	Quarter March Creek, VA	222	N	bucket/ hydraulic	confined behind bulkhead and earthen berm	2619
11/9/76	Bay Property Assoc.	Queen Ann Creek, VA	300	N	dragline	upland behind earthen berm	2685
12/20/76	City of Newport News	Salter's Creek, VA	5	N	backhoe	upland	2916
6/27/77	Baycliff Civic League	Mill Dam Creek, VA	3,777	M	dragline	upland	3282
7/14/77	VA Dept. of Highways and Transportation	Vaughans Creek, VA	257	N	bucket	upland or used within roadway prism	3219
10/19/76	VA Dept. of Highways and Transportation	Rappahannock River, VA	36,115	N	dragline, bucket or hydraulic	upland in existing borrow pit	2786
4/5/77	Tierra Fin, Inc.	Rappahannock River, VA	1,000	N	hydraulic pump		3119
6/15/77	Town of Culpepper	Rappahannock River, VA	155	N	bucket	upland	3175
10/17/77	Boater's World	Rappahannock River, VA	1,200	M	dragline	existing upland disposal area	3424
5/27/77	S.R. Goodman	Piankatank River, VA	200	N	dragline	beach replenishment	2582
5/26/77	VA Dept. of Highways and Transportation	Pocoshock Creek, VA	143	N	bucket	used within roadway prism	3187
10/21/76	VA Dept. of Highways and Transportation	N. Anna River, VA	185	N		within roadway prism	2785
2/23/77	Isle of Wight County	James River, VA	2,100	M	bucket	beach replenishment or dispose of at county land-fill or an upland area	3151
3/30/77	VA Dept. of Highways and Transportation	James River, VA	20,000	M	bucket	overboard	3285
4/4/77	VA Dept. of Highways and Transportation	James River, VA	403	N	bucket	within roadway prism	3160
8/11/77	Lone Star Industries	James River, VA	1,800	M	bucket	recycled for aggregate reproduction or upland fill	3238
12/17/76	Hampton Roads Sanitation District	Wayne Creek, VA	15	N	dragline	upland behind earthen berm	2971
3/25/77	Naval Facilities Engineering Command	Willoughby Bay, VA	285,000	M	hydraulic	pumped directly into Craney Island disposal area	2884
1/28/77	Oceanside Campsites	Machipongo River, VA	10,000	M	hydraulic	upland, adjacent upland bermed disposal area	3018
7/5/77	VA Dept. of Highways and Transportation	Massaponax Creek, VA	557 15 572	N	bucket		3269
6/1/77	VA Dept. of Highways and Transportation	Mill Pond, VA	5,400 3,900 9,300		bucket or dragline		2976

TABLE A-25 (concluded)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1977

Date	Permittee	Location	Total Amount Dredged	N M	Method Used for Dredging	Disposal Site	File Number
1/31/77	VA Dept. of Highways and Transportation	Hampton Creek, VA	2,167	N	clamshell/ backhoe	within roadway fill	3065
11/23/76	Naval Facilities Engineering Command	Hampton Roads, VA	200,000	N		Craney Island Disposal area	2914
12/20/76	City of Newport News	Hampton Roads, VA	11	N	dragline	upland	2866
3/29/77	VA Port Authority	Hampton Road, VA	180,000	M	hydraulic	Craney Island disposal area	3134
7/22/77	Naval Facilities Engineering Command	Hampton Roads, VA	681,000	N	bucket/ hydraulic	Craney Island disposal area	2711
12/21/76	Robert McDonald	Indian Creek, VA	589	N	bucket	upland behind existing bulkhead for beach replenishment	2803
3/29/77	Harwood V. Pointer	Ingram Bay, VA	100	N		material used to fill sandbags	3105
1/14/77	City of Richmond	James River, VA	70	M	bucket	upland fill	2947

TABLE A-26
DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1978

Date	Permittee	Location	Total Amount Dredged	N M	Method Used For Dredging	Disposal Site	File Number
3/24/78	Lone Star Industries	James River, VA	1,500	M	bucket	upland or recycled	3241
7/2/78	VA Dept. of Highways and Transportation	James River, VA	11,000 2,300 13,300	M	bucket	Craney Island disposal area. Some used for upgrading	3662
5/9/78	J. Calvitt Clarke	Linkhorn Bay, VA	170	N	dragline	upland behind proposed bulkhead	1869-06
12/16/77	Russell F. Craig	Little Neck Creek, VA	125	N		upland behind bulkhead	2698
5/17/78	Glebe Point Boat Co.	Great Wicomico River, VA	155	N	bucket	upland	1735-01
10/31/77	Naval Facilities Engineering Command	Hampton Roads, VA	125,000	N	bucket or hydraulic	pumped into Craney Island disposal area	3463
3/24/78	Lone Star Industries	Hampton Roads, VA	1,000	M	bucket	used as fill and deposited on an upland area	3241
6/19/78	Northern Neck Real Estate Corporation	Harveys Creek, VA	4,000	N	hydraulic	upland on to adjacent upland site and confined	3455
2/16/78	Captain W.C. Magee	Henry's Creek, VA	4,000	N	bucket	upland	2822
10/3/77	D.T. West	Oyster Bay, VA	23	M	backhoe	upland into adjacent land, confined and stabilized	003 411
1/24/78	Northampton County Board of Sup.	Oyster Harbor, VA	1,000	N	clamshell	upland	003 212
5/30/78	Abner N. Thompson, Jr.	Mill Creek, VA	2,300	N	hydraulic	piped to existing upland, bermed disp. area	003 606
3/20/78	Peyton Hundley, Jr.	Rappahannock River, VA	300	M	dragline	to existing upland disp. area	003 424
7/5/78	Norfolk Dredging Co.	Newport News Creek, VA	112,360	M N	hydraulic	pumped to Craney Island disposal area	003 775-02
12/20/77	Whelan's Marina	Morattico Creek, VA	100	N	dragline	area adjacent to channel	25D 002 1002 059
6/19/78	Billy R. Clark	Mosquito Creek, VA	900	M	bucket	adjacent upland site	003 037
3/20/78	Ro-Hut Inc.	Mosquito Creek, VA	240	N	bucket	trucked to upland disposal area	80-0133-02
5/26/78	Lone Star Industries	Nansemond River, VA	10,000	M	bucket	part of material used for backfill rest disposed of in Craney Island Rehandling Basin	003 237
8/8/78	Duff Green Porter	Scotts Creek, VA	300	M	bucket	behind bulkhead	003 171
3/21/78	Lone Star Industries	Appomatox River, VA	5,500	N	bucket or hydraulic	material pumped to existing borrow areas and confined	3367
5/10/78	Wilson Duke	Broad Creek, VA	600	N	bucket	upland	3395
4/11/78	Elliott Bloxom	Carter Cove, VA	60	N	bucket	upland	3391
11/28/77	Russell Fish Company	Chincoteague Channel and Inlet, VA	417	N	bucket	upland disposal site	3320
12/12/77	Blyth and Son, Inc.	Chuckatuck Creek, VA	1,000	N	bucket	upland, confined behind bulkhead	3435
6/12/78	Albert E. Pollard	Corrotoman River, VA	300	M	dragline	upland, behind existing bulkhead	3490
3/28/78	Keffer Marine Service	Deep Creek, VA	11,000	M	dragline	upland	2450
6/1/78	Herbert Dehnert	Dyer Creek, VA	90	N	bucket	upland, behind earthen berm	3699-02
6/27/78	Frederick Ajootian	Dymer Creek, VA	110	N	bucket	upland, behind earthen berm	3877-03
2/28/78	Lone Star Industry	Sunset Creek, VA	2,200	M	bucket	recycled or used as upland fill material	3239
10/25/77	Richard T. Ray	Stalton's Creek, VA	125	N	bucket	upland, contained behind bulkhead	3448
3/20/78	Albert M. Edmonds	Indian Creek, VA	200	N	bucket	upland and confined	3665
1/24/78	Jordon Marine Railway	Sarah Creek, VA	100	N	bucket	upland	3653
4/11/78	George E. Hannah and Roscoe Meadows	Perrin River, VA	2,000	N	bucket	upland and confined behind earthen berm	3303
4/18/78	Lower Chesapeake Yacht Center	Perrin River, VA	7,000	N	hydraulic	pumped into a bermed disposal area	3367

TABLE A-26 (concluded)
DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1978

Date	Permittee	Location	Total Amount Dredged	N M	Method Used For Dredging	Disposal Site	File Number
1/8/78	Northeastern Motor, Inc.	Pasquotank River, VA	780	N	dragline	upland, behind existing bulkhead	3576
3/29/78	Robert L. Thompson	Pasquotank River, VA	100	M	dragline	used in project	3706-03
2/16/78	West Neck Boat Yard and Marina	West Neck Creek, VA	1,500	N	bucket/backhoe	upland, confined behind earthen berm	3271
1/5/78	City of Norfolk	Willoughby Bay, VA	9,500	N	bucket	used for beach replenishment	3494
12/5/78	T.E. Beauchamp	Winter Harbor, VA	180	M	bucket	upland, behind earthen berm	3393
4/25/78	W.T. Hardstock	Onancock River, VA	1,000	N	hydraulic	upland into bermed disposal area adjacent to project	3313
11/15/77	W.W. Gwathmey	Southern Branch of Elizabeth River, VA	3,361	M	bucket	hauled by truck to an upland disposal site	3318
11/2/77	VA Dept. of Highways and Transportation	Jacks Creek, VA	267 572 839	M	bucket	upland disposal area	3375
1/17/78	Hawthorne Corporation	Jackson Creek, VA	600	M	bucket	upland behind existing bulkhead	2375
10/5/77	Electric and Power Co.	James River, VA	350,000	M	hydraulic	material pumped directly upland into disposal area and confined behind an earthen berm	2173
4/18/78	Jamestown-Yorktown Foundation	James River, VA	12,200	N	upland		3636
10/19/77	Isle of Wight County	James River, VA	400	N	bucket	material transported to 2 upland areas and confined	3151
11/18/77	Commonwealth Nat. Gas Corporation	James River, VA	110,000	N	bucket	Craney Island disposal area	3226
2/24/78	VA Commission of Game	James River, VA	30	N	bucket	upland	3195
2/28/78	Lone Star Industries	James River, VA	2,500	M	bucket	recycled as aggregate or used as upland fill	3242

TABLE A-27

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1979

Date	Permittee	Location	Total Amount Dredged	S M	Method Used For Dredging	Disposal Site	File Number
9/5/79	William H. Goodman	Pasquotank River, VA	360	S	dragline	upland behind bulkhead	8903
9/6/79	City of Elizabeth	Pasquotank River, VA	275	S	dragline	upland upon existing spoil area	2765
8/10/79	VA Dept. of Highways and Transportation	Assateague Channel, VA	ditch: 900ft.^{3} 1.5 ft. deep 3 ft. wide 300 ft. long = 33yd^3	S	bucket	within roadway prism	78-4417-02
8/27/79	York Co. Dept. of Leisure Services	Back Creek, VA	135	S	bucket	upland	78-4378-02
6/5/79	City of VA Beach	Thalia Creek, VA	355	S	bucket	upland and confined behind earthen berm	003754-02
9/28/79	Arthur R. McElroy	Tide Mill Creek, VA	30	S	bucket	wetland landward of bulkhead	78-4294-02
5/3/79	Koch Fuels, Inc.	James River, VA	60,000	M	bucket	barged to Craney Island disposal site	78-4418-02
9/12/79	Railway Chesapeake and Ohio	James River, VA	30,000	S	clamshell	Craney Island Rehandling	79-0143-03
12/12/78	George Dragas, Jr.	Little Neck Creek, VA	225	S	dragline or bucket	trucked to upland disposal	003894-06
9/7/79	Edwin S. Brock, Sr.	Little Neck Creek, VA	700	S	dragline	upland behind bulkhead	79-0138-03
5/15/80	Clyde R. Hoey	Little Neck Creek, VA	45	S	bucket	upland; some of the material used as backfill	79-0361-02
2/12/80	Colonial National Historic Park	York River, VA	27	S	bucket	upland to York county landfill project	79-0448-02
3/03/79	VA Dept. of Highways and Transportation	London Bridge Creek, VA	846	S	clamshell	upland adjacent disposal site and confined	3694
3/5/79	D. Garland Moore	Lyons Creek, VA	900	S	bucket		3111
3/23/79	Richard Broken-borough	Robinsons Creek, VA	300	S	dragline	upland behind earthen berm	3302
10/12/78	Exxon Co., Inc.	Hampton Roads, VA	43,000	M	bucket and/or hydraulic	Craney Island	1003703-01
4/3/79	Marrimac Shores Yacht Basin	Hampton Roads, VA	700	M	bucket	barged and disposed of on upland site	1003925-03
8/24/79	Continental Grain Co.	Hampton Roads, VA	143,000	S	hydraulic	Craney Island Disposal site pumped directly	78-4307-02
5/22/79	Cully's Railway	Harpers Creek, VA	860	S	dragline	Adjacent upland area	003903-05
8/10/79	M.C. Alson		500	S	dragline	upland and confined behind earthen berm	79-0034-03
5/2/79	Hunton Creek Assoc.	Hunton Creek, VA	1,000	M	bucket	upland and confined behind earthen berm	3169
11/13/78	Chesapeake Boat Basin Inc.	Indian Creek, VA	3,200	S	bucket	upland behind bulkhead	3599
11/7/78	Newport News Ship-building	James River, VA	110,000	S	bucket	Craney Island Disposal area	3700-01
12/5/78	Allied Chemical Corp.	James River, VA	33,000	M	hydraulic	Overboard disposal site by pipeline	3447
5/2/79	Garland Humphries City of Chesapeake	Dismal Swamp Canal, VA	82	S	dragline	upland	78-4403-01
3/2/79	City of Norfolk	Eastern Branch of Elizabeth River, VA	2	S	clamshell and/or dragline	upland	78-4247-03
10/31/79	Weaver Fertilizer Co.	Southern Branch of Elizabeth River, VA	850	S	bucket	2 upland sites and contained behind earthen berm	1004070-07
3/7/79	Langley Air Force Base	Back River, VA	51,900	M	hydraulic	pumped directly to a disposal site confined behind earthen berm	003745-02
6/13/79	John W. Harris	Back River, VA	17	S	bucket	upland and confined behind earthen berm	004-019-02
9/17/79	VA Dept. of Highways and Transportation	Brights Creek, VA	50	M	bucket	in wetland area and upland on disposal site	79-0018-02

TABLE A-27 (concluded)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1979

Date	Permittee	Location	Total Amount Dredged	N M	Method Used For Dredging	Disposal Site	File Number
9/17/79	VA Dept. of Highways and Transportation	Brights Creek, VA	50	M	bucket	in wetland area and upland on disposal site	79-0018-02
3/07/79	F.J. Swearigen, Jr.	Broad Creek, VA	35	N	bucket	upland disposal site	004102-03
7/18/79	Nortons Marina, Inc.	Broad Creek, VA	4,970	M	hydraulic	triangle shaped bermed disposal area	003102-02
3/2/79	Earl Cockrell	Great Wicomico River, VA	260	N	bucket	upland, confined behind earthen berm	1004216-02
10/16/78	Leslie T. Cox	Fishermans' Cove, VA	250	N	dragline	upland behind bulkhead	3616
9/20/78	Harry E. Austin	Pasquotank River, VA	925	N	dragline	used as backfill for bulkhead	395603
5/10/79	Perioc Corp.	Perrin River, VA	1,400	N	dragline	upland 60 ft. away from project	78-4460-01
10/4/78	Aluminum Co., Company of America	Paradise Creek, VA	17,800	N	hydraulic or bucket	Craney Island Rehandling Basin	388003
10/12/78	City of Portsmouth	Paradise Creek, VA	50	N	clamshell	upland to adjacent drainage easement and confined	394502
1/9/79	Naval Facilities Engineering Command	York River, VA	445,000	N	hydraulic	Craney Island Disposal area	3553
5/7/79	Amoco Oil Co.	York River, VA	178,000	N	hydraulic	pumped directly to several upland disposal areas and confined behind earthen berm	4278-02
5/17/79	Marshall Seafood	Butler's Creek, VA	1,400	N	dragline	upland confined behind earthen berm	3854-01
12/8/78	Humphrey's Railway, Inc.	Carter Cove, VA	1,896	M	bucket	temporary open water disposal sites surrounded by turbidity curtains	3856-02
8/11/78	VA Commission of Game and Inland Fisheries	Back Bay, VA	800	N	hydraulic	upland, confined behind earthen berm	3611
8/31/78	John R. Erdman	Back Creek, VA	500	N	bucket	upland	2518
8/23/78	Greenvale Farms Civic Assoc.	Belmont Creek, VA	2,500	M	hydraulic	upland, pumped into adjacent disposal area	778-02
8/28/78	Charles E. Pritchard	East River, VA	160	M	bucket	upland, behind earthen berm	3657
9/18/78	Colonna's Shipyard	Eastern Branch of Elizabeth River, VA	10,000	N	clamshell	Craney Island or upland behind berm	3815-08
9/1/78	Intercoastal Steel Corporation	Southern Branch of Elizabeth River, VA	10,000	N	bucket	upland behind existing bulkhead	3335
2/25/78	Royster Co.	Southern Branch of Elizabeth River, VA	170,000	N	bucket	Craney Island Rehandling Basin	DACW65-78-C-0038
9/18/78	First Energy Co.	James River, VA	180	M	dragline	Upland disposal city maintained	3915-03
7/3/78	Regent Point Marina	Locklies Creek, VA	30	N		upland	3787-01
9/17/79	VA Dept. of Highways and Transportation	Three Creek, VA	576	N	bucket	within roadway prism or disposal area	4280-02
4/11/79	Gorden Robins	Urbanna Creek, VA	450	N	dragline	upland and confined behind earthen berm	78-4427-01
3/26/79	Gloucester Enterprises	Sarah Creek, VA	1,750	N	bucket or hydraulic	upland and confined behind bermed area	3655
6/4/79	Larry Wayne Hoskins	Quarter March Creek, VA	17	N	backhoe or hydraulic	upland behind bulkhead	3990-02
8/1/79	John K. Nice	Quarter March Creek, VA	19	N	hydraulic	upland, use for fill	4232-03
6/7/79	C.M. Ware	Queen Creek, VA	82	N	dragline	backfill, excess goes to upland disposal	78-4403-01
7/11/79	VA Dept of Highways and Transportation	Morattico Creek, VA	40	N	clamshell	within roadway prism	3919-03
9/27/79	VA Dept of Highways and Transportation	Nansemond River, VA	143,031	N	bucket	Craney Island Disposal Area and Rehandling Basin	3789-02
8/1/79	South Hampton County	Nottoway River, VA	1	N		upland	4124-02
6/15/79	Windmill Point Marina	Rappahannock River, VA	5,500	M	4500 cu. yds. hydraulic 1000 cu. yds. dragline	bermed disposal area	79-0010-03

TABLE A-28

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1980

Date	Permittee	Location	Total Amount Dredged	N M	Method Used For Dredging	Disposal Site	File Number
12/17/79	Colonial Nat. Historical Park	York River, VA	3,900	N	bucket	upland York County Landfill Project	78-0493-07
10/30/79	C.H. Butler, Jr.	Bush Park Creek, VA	80	N	bucket	upland behind bulkhead	3796-01
4/7/80	Norman Van Jester	Lewis Creek, VA	935	M	dragline	upland disposal area, privately owned	79-0221-03
9/12/80	Messrs. Edward H. Harrell Jr. et. al.	Lynnhaven River, VA	4,500	N	hydraulic	pumped directly on upland site	79-0105-02
5/30/80	Colonial Pipeline Co.	Western Branch of Elizabeth River, VA	925	N	bucket	upland, then reused	79-0759-01
9/4/80	VA Dept. of Highways and Transportation	Southern Branch of Elizabeth River, VA	1,142,000	N	clamshell	unusable material barged to Craney Island Rehandling Basin	79-0777-06
9/30/80	Gregory J. Marable	Southern Branch of Elizabeth River, VA	40	N		use for backfill	80-0376-07
9/4/80	Virginia Chemicals, Inc.	Western Branch of Elizabeth River, VA	60	M		momentarily stored on adjacent site	80-0178-07
2/12/80	Colonial National Historical Park	Felgates Creek, VA	27	N	bucket	York County landfill	79-0448-02
9/4/80	Norfolk Dredging Co.	Albermarle and Chesapeake Canal VA Cut, VA	25,000	N	clamshell	barged to upland disposal	79-0742-02
11/19/79	Marvin E. George	Antipoison Creek, VA	500	N	bucket	adjacent upland disposal area, confined behind earthen berm	78-4386-02
12/31/79	VA Dept. of Highways and Transportation	Baines Creek, VA	985	N	dragline	within roadway prism	79-0250-02
9/2/80	Dismal Swamp National Wildlife Refuge	Dismal Swamp, VA	2,000	N	dragline and hydraulic	part deposited into a roadway, rest upland	80-0250-06
6/18/80	Virginia Tractor Co.	Southern Branch of Elizabeth River, VA	25,600	N	bucket	Craney Island Disposal Area	79-0774-06
8/27/80	Equipment Unlimited Inc.	Eastern Branch of Elizabeth River, VA		M	clamshell	backfill for bulkhead	79-0704-07
2/19/80	City of Suffolk	James River, VA	900	N	bucket	Craney Island Rehandling Basin	3838-06
2/28/80	City of Newport News	James River, VA	30	N	bucket	adjacent upland confined disposal	79-0117-02
12/31/79	Tidewater Boat Club	Knitting Mill Creek, VA	3,000	M	dragline	Norfolk's Lambert Landfill	79-0363-03
5/9/80	Colonial Pipeline Co.	Lake Anna, VA	407	N	bucket	upland, behind earthen berm	79-0784-02
4/7/80	City of VA Beach	Lake Rudee, VA	50	N	dragline	upland disposal	79-0599-03
3/27/80	Mr. Gary Price	Lake Rudee, VA	335	N	bucket	upland and confined	80-129-02
3/14/80	Dr. Charles Lloyd	Stutts Creek, VA	400	M	dragline	upland on adjacent field	79-0682-07
7/21/80	William B. Smith	Taylor Creek, VA	2,330	N	hydraulic	upland bermed area	79-0402-07
3/13/80	Frederick J. Petringer, III	Scotts Creek, VA	1,130	N	bucket	behind earthen berm	79-0188-02
9/4/80	City of Portsmouth	Scotts Creek, VA	65	N	bucket	recycled	80-0129-05
9/3/80	City of Hampton	Hampton River Creek, VA	23,800	M	bucket	Craney Island Rehandling Basin	80-0029-03
10/29/79	Naval Facilities Engineering Command	Hampton Roads, VA	67,000	N	hydraulic	pumped directly to Craney Island Disposal Area	79-0261-02
1/11/80	Norfolk Shipbuilding and Drydock Co.	Eastern Branch of Elizabeth River, VA		M	bucket	Craney Island Disposal Area	79-0580-03
4/16/80	VA Dept. of Highways and Transportation	Ware River, VA	11	N	bucket	within roadway prism or upland	78-4414-02
7/9/80	E. Claiborne Robins, Jr.	Ware River, VA	1,200	M	clamshell	367 used for fill 75 as backfill rest graded into adjacent property	79-0643-07
2/12/80	Lillian Williams	Sheephead Creek, VA	318	N	bucket	upland landward of new bulkhead	3881-02

TABLE A-28 (concluded)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: NORFOLK DISTRICT; FISCAL YEAR 1980

Date	Permittee	Location	Total Amount Dredged	N M	Method Used For Dredging	Disposal Site	File Number
10/4/79	U.S. Army Transportation Center and Fort Eustis	Skiffers Creek, VA	2,000,000	M	hydraulic	upland into bermed area	4106-01
2/19/80	City of Suffolk	Nansemond River, VA	1,400	N	bucket	Craney Island Rehandling Basin	3879-06
2/28/80	Kenneth N. Whitehurst	Nawney Creek, VA	1,067	N	bucket and/or dynamic	onto adjacent wetlands	79-0286-02
4/10/80	VA Dept. of Highways and Transportation	New Market Creek, VA	10	N	bucket	upland or within roadway prism	79-0488-02
9/15/80	City of VA Beach	North Landing River, VA	1,400	N	bucket	part used in bridge construction remainder transported to upland disposal	80-0111-02
9/8/80	Chelsea Waterway Assoc.	Broad Bay, VA	8,500	M	hydraulic	pumped to disposal sites and confined	79-0365-07
5/21/80	Gideon Enterprises	Belle Mill Creek, VA	4,000	N	dragline	upland into adjacent bermed disposal area	00261-06
11/7/79	Frank E. Mueller	Bleakhorn Creek, VA	100	N	backhoe	upland behind earthen berm	79-0179-06
9/16/79	VA Dept. of Highways and Transportation	Brights Creek, VA	134	N	dragline	material used for the placement of bridge abutments	79-0268-02
7/8/80	Norview Marina	Broad Creek, VA	12,000	N M	hydraulic	pumped directly into adjacent disposal area and confined by earthen berm	4173-02
5/9/80	Colonial Pipeline Co.	Pamunkey River, VA	419	N	bucket	upland behind earthen berm	79-0784-02
1/17/80	Moon Shipyard and Repair Corp.	Eastern Branch of Elizabeth River, VA	6,200	N	dragline	Craney Island	79-0547-01
7/16/80	U.S. Coast Guard Fifth District	Chincoteague Channel, VA	7,000	M	bucket	trucked to a disposal area on Willow Street	79-0743-01
10/15/79	Douglas V. Braley	Dymer Creek, VA	515	N	bucket	upland into bermed disposal	78-4405-02
12/28/79	Hampton Roads Energy Company	Elizabeth River, VA	3,400,000	N	hydraulic	pipeline to Craney Island	1-002256
7/3/80	Norfolk and Western Railway Company	Elizabeth River, VA	170,000	M	hydraulic and/or bucket	Craney Island Disposal Area	80-0049-03
10/10/79	Allied Marine Industry Inc.	Eastern Branch of Elizabeth River, VA	3,200	N	hydraulic	barged to Craney Island Disposal Area	79-0185-02
1/5/80	City of Newport News	Hampton Roads, VA	30	N	dragline	upland	79-0118-03
8/17/80	Annie B. Shall	Rappahannock River, VA	50	N	dragline	upland and confined behind earthen berm	79-0489-03
8/2/80	Gary Holland	Rudee Inlet, VA	35	N	dragline	upland site	80-0236-03
12/31/80	Dennis M. Bushnell	Timberneck Creek, VA	17	N	hand tools	upland, bermed area on same property	79-0350-03
4/25/80	Hampton Roads Sanitation District	Hampton Roads, VA	287,100	N	clamshell	upland	79-0522-03
9/4/80	VA Dept. of Highways and Transportation	Hazel Run, VA	605	N	bucket	excess on roadway prism	79-0399-02
10/21/79	Wildlife Service	James River, VA	80	M	dragline	upland behind bulkhead	79-0438-03
10/24/79	Williamsburg Foundation	James River, VA	215	N	hydraulic	spoil used in project construction	79-0461-02

TABLE A-29

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1975

Date	Permittee	Location	Total Amount Dredged	N M	Method Used For Dredging	Disposal Site	File Number
6/16/75	Kent Island Limited Limited Partnership	Chesapeake Bay near Stevensville, MD	75,000	M	hydraulic	upland and retained behind an earthen dike on applicant's property	
6/16/75	Kent Island Limited Partnership	Chesapeake Bay near Stevensville, MD	7,400	M	hydraulic	upland and retained on applicant's property	74-611
4/15/75	Flab Harbor Corp.	Chesapeake Bay at Long Beach, MD	13,000	N			74-441
10/4/74	Havre de Grace, Mayor and City Council	Chesapeake Bay at Havre de Grace, MD	28,000	N		behind dike on applicant's property	74-172
4/17/75	Smith, Neal, Jr.	Charleston Creek, MD	175	N		upland spoil site	74-968
6/19/75	Anne Arundel County, Dept. of Public Works	Chesapeake Bay at Beverely Beach, MD	12,000	N	clamshell	11,070 cu yd used as back-fill. Rest disposed of upland	73-1226
6/12/75	Snug Harbor Citizens Association	Chesapeake Bay near Shady Side, MD	1,854	N		landward of bulkhead and earthen barriers	73-831
6/2/75	Research Homes, Inc.	Chesapeake Bay at Bodkin Point, MD	2,050	N	clamshell	landward of shoreline	74-110
2/2/75	Fairfax Co. Dept. of Public Works	Cameron Run, VA	700	N	mechanical	500 cu yd used for stream backfill, rest deposited landward in disposal area	74-742
11/25/74	Green, William	Carr's Creek, MD	10	N	dragline	retained behind bulkhead	74-188
6/4/75	Bay City Improvement Association	Broad Creek, VA	110	N	dragline		73-725
10/18/74	Durr, Williams	Bodkin Creek, MD	1,800	N		deposited and retained an upland site	73-119
6/2/75	Research Homes, Inc.	Bodkin Creek, MD	110,000	N		landward of shoreline	73-1023
3/27/75	Bohemia River Marina	Bohemia River, MD	9,400	N		upland disposal	74-603
3/7/75	Baltimore Co. Dept. of Public Works	Bear Creek, MD	760	N	clamshell or dragline	480 cu yd used as land-fill, rest barged to disposal area	74-1023
1/27/75	Trojan Yacht	Big Elk Creek, MD	10,000	N		diked upland disposal area	74-323
1/27/75	Calvert County	Back Creek, MD	350	N		behind bulkhead	74-678
12/18/74	Melville, Thomas	Balls Creek, MD	210	N		landward of shoreline	74-414
11/22/74	Bayside Properties, Inc.	Bat Creek, MD	5,000	N		diked area on shoreline on applicant's property	73-37
8/17/74	Zahniser, Albert	Back Creek, MD	1,000	N		landward of bulkhead	73-1217
12/10/74	Cloverfield Improvement Association	Chester River at Cloverfield, MD	3,600	N	dragline	2 upland disposal sites on applicant's property	73-1216
4/29/75	Somerset County Recreation and Park Commission	Goose Creek at Rumbley, MD	10,000	N	dragline and hydraulic	deposited and retained landward of MHW shore-line	74-1003
1/13/75	Ritz, Jack M.	Galloway Creek, MD	500	N	dragline	deposited and retained landward of MHW shoreline	74-413
11/4/74	Gaster, G.	Elk River, MD	30,000	N	hydraulic	deposited and retained on applicant's property	73-740
4/9/75	U.S. Naval Facilities Engineering Command	Dorsey Creek, MD	14,500	N			74-947
12/11/74	Campbell, Robert	Elk River at Elkton, MD	80	N	backhoe	landward of MHW on applicant's property	74-694
2/14/75	Hull, Sam E. et al.	Cypress Creek, MD	600	N		to be placed landward of bulkhead	74-139
3/7/75	Edwards, Donald	Davis Creek, MD	200	N	dragline	deposited and retained landward of MHW shoreline	
12/20/74	W.R. Grace and Co.	Curtis Creek near Sledds Point, MD	400	N	clamshell	deposited and retained in a diked area	74-782
5/16/75	W.R. Grace and Co.	Curtis Creek near Sledds Point, MD	5,000	N	hydraulic	landward of MHW in diked area on applicant's property	75-94
12/6/74	U.S. Coast Guard	Cutris Bay, MD	12,000	M	clamshell		74-876
2/10/75	Balch, Henry H.	Cox Creek near Bayfields, MD	175	N	dragline	upland site	74-719

TABLE A-29 (continued)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1975

Date	Permittee	Location	Total Amount Dredged	N M	Method Used For Dredging	Disposal Site	File Number
1/3/75	Zepp, G.T.	Colburn Creek at Marion MD	50	N		deposited and retained landward of bulkhead	74-423
10/8/74	Greenhawk, Lenoard	Church Creek, MD	450	N		deposited, spread, seeded and retained landward	73-958
3/18/75	Tieder, J.W., Inc.	Choptank River, MD	1,000	N		landward of MLW shoreline	74-920
5/27/75	Towsend, Victor	Chincoteague Bay near Handys Hammock, MD	292	N	dragline		74-519
11/11/74	Anderson, Charles	Canal of Gunpowder River at Joppotowne, MD	3,000	N	hydraulic	behind earthen berm landward of MHW shoreline	73-1333
3/18/75	MD State Dept. of Transportation	Gwynns Fall, MD	13,650	N		trucked and deposited into upland disposal	74-473
1/20/75	U.S. Navy Chesapeake Division	Harper Creek, MD	2,000	N	clamshell	upland, deposited and retained landward of MHW shoreline	73-227
5/29/75	Bertenfelder, Harry	Hopkins Creek near Essex, MD	40	N	boom crane	deposited and retained landward on applicant's property	74-913
4/15/75	Columbia LNG Co.	Hunting Creek, Stoakley, MD	14,300	N	bucket	backfill over pipeline	74-341
10/11/74	Pase, Quentin W.	Island Creek at Saint George, MD	150	N	dragline	upland site	73-935
5/27/75	Showell, John Dale	Isle of Wight Bay at Ocean City, MD	3,200	N	hydraulic	landward of MHW shoreline in disposal site	74-185
6/9/75	C. and T. Land, Inc.	Jackson Creek near Grasonville, MD	250	N	dragline	trucked on applicant's property, landward of MHW shoreline	75-75
6/20/75	Sewards' Point Marina	Kent Narrows near Grasonville, MD	450	N	dragline	deposited and retained on upland site	75-398
11/26/74	Yeastat, Bernard G.	Knapps Narrows at Tighlman, MD	120	M		retained landward of MHW shoreline	73-1254
9/20/74	Anchorage Swim Club, Inc.	Lake Ogleton at Beale Manor, MD	312	N		landward of bulkhead	74-279
1/28/75	MD State Dept. of Natural Resources	Lake Conoy, MD	68,000	N		landward of MHW shoreline	74-761
2/14/75	Danz, Carl B.	Little Round Bay near Mathiers Point, MD	150	N		behind bulkhead	74-780
6/17/75	Hutchinson, Karl J.	Lowry Cove, MD	22,800	N		landward of MHW shoreline	
10/23/74	Hirsch, Thomas E., Jr.	Magothy River, MD	1,000	N		landward of MHW shoreline	73-549
3/5/75	Boise Cascade Home and Land Corp.	Manklin Creek at Ocean Pines, MD	40,000	N		landward of MHW shoreline	73-586
5/22/75	Cheseldline, Joseph E.	Shannon Branch of Yeocomino River, VA	150	N	bucket	landward of MHW shoreline	74-933
6/12/75	Hughes, Helene W.	Chipping Creek near Batts Neck, MD	2,000	N		behind dike landward of MHW shoreline	74-329
11/25/74	Kapland, Mitchell A.	South River near Boyd Point, MD	60	N		landward of existing bulkhead	74-491
2/10/75	Maryland State Dept. of Natural Resources	Susquehanna River near Havra de Grace, MD	210	N	dragline	placed and retained behind bulkhead	74-890
1/13/75	Lewisburg Area Joint Sewer Authority	Susquehanna River near Lewisburg, MD	75	N		landward of MHW shoreline	NAPOP-F14
2/5/75	Metropolitan Edison Co.	Susquehanna River at 3 mile Island, PA	1,100	N	hydraulic	upland disposal on island	75-83
1/10/75	Dugan, Michael	St. Thomas Creek, Sotterley Point, MD	1,400	N		landward of MHW shoreline	74-443
2/18/75	J. Lawson Gilbert Distributors, Inc.	Susquehanna River at Havre de Grace, MD	2,925	N	dragline	deposited and retained above MHW shoreline	73-1347
11/19/74	Boise Cascade Home and Land Corp.	St. Martin River near Cedar Point, MD	8,600	N	hydraulic	landward of MHW shoreline	74-173
11/21/74	Fayed, James J.	St. Peters Creek, MD	200	N	dragline	deposited and retained landward of bulkhead	73-911
5/2/75	The B&O Railroad Co.	Patpsco River at Baltimore Harbor, MD	80,000	M	bucket	diked containment on applicant's property	74-674

TABLE A-29 (continued)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1975

Date	Permittee	Location	Total Amount Dredged	N M	Method Used for Dredging	Disposal Site	File Number
2/11/75	Lynn, Fred M.	Occoquan River at Occoquan, MD	50	N	clamshell	landward of MHW shoreline	74-583
10/25/74	Harford Co. Dept. of Public Works	Otter Point Creek at Otter Point, MD	2,000	N		landward of MHW shoreline	73-991
10/28/74	Town Commissioner at Charleston	Northeast River at Charlestown, MD	70	N		deposited and retained on applicant's property	74-604
3/19/75	Clayton's Marina	Jutland Creek, MD	5,000	N	clamshell	on disposal site applicant's property	74-600
1/24/75	Ruark + Ashton Seafood Co.	Muddy Hook near Hoopersville, MD	350	N	dragline	landward of MHW shoreline	74-523
1/15/75	Gilbert, Patricia A.	Nan's Cove at Broome's Island, MD	75	N		landward of bulkhead	73-957
2/18/75	Gomes, Robert, and Cox, R.	Saltpeter Creek near Bengies Point, MD	4,550	N	dragline	deposited and retained landward of MHW shoreline	73-514
5/27/75	Phillips, Van R.	San Domingo Creek near St. Michaels, MD	110	N		upland of MHW shoreline	75-29
1/8/75	Holland Cliff Shores Assn.	Patuxent River at Holland Cliff, MD	1,500	N		landward of MHW shoreline	73-1354
11/27/74	Johnston, William D.	Patuxent River, unnamed cove, MD	340	N		behind bulkhead	73-1142
4/28/75	Maryland State Port Administration	Patapsco River Baltimore Harbor, MD	18,000	N	dragline	barged to Arundel Corp. Property and retained	74-1037
7/2/75	Meyer, Robert C.	Patapsco River at Glen Burnie, MD	25	N		landward of MHW shoreline	75-157
5/2/75	Western Maryland Railway	Middle Branch of Patapsco River at Hawkins Point, MD	80,000	M	bucket	behind diked area on fast-land in Patapsco River	NABOP-F/2
5/8/75	Abell, Vernon F.	Patuxent River at Solomons Island, MD	390	N	dragline	deposited and retained behind bulkhead	73-356
6/3/75	Maryland State Dept. of Transportation	Patapsco River at Baltimore MD	91,000	N	clamshell	deposited and retained landward of MHW shoreline	75-209
4/23/75	Glidden-Durkee Division of SCM	Patapsco River at Hawkins Point, MD	10,000	N	clamshell	channelward of MHW shore-line	74-480
11/6/74	Bethlehem Steel Corp.	Northwest Branch of the Patapsco at Sparrows, MD	20,000	N	dragline	retained upland	73-1253
2/27/75	Hooks, Wingate E.	St. George Creek at Hodgson, MD	170		dragline	deposit and retained landward of bulkhead	74-81
3/13/75	Powell, Paul K	St. Jerome Creek near Ridge, MD	1,000			behind bulkhead	74-676
10/3/74	Wise, Ralph H. and Pullion, William	St. Jerome Creek near Ridge, MD	730		dragline	diked disposal	73-1186
4/15/75	Columbia LNG Corp.	St. Leonard Creek, MD	25,300		bucket	used as fill over pipeline	74-340
11/8/74	Boise Cascade Home and Land Corp.	St. Martin River and Manklin Creek, MD	32,000		clamshell or dragline	landward of MHW shorline	73-585
5/12/75	Delmarva Water Transprotation Committee Inc.	Wicomico River near Salisbury, MD	84,150	M	hydraulic	upland in approved spoil site in Wicomico River	75-308
8/19/75	General Services Admin.	Potomac River at Potomac Pk, MD	850	M	clamshell	rainwaters landfill	75-257
1/3/75	Bauman, Henry	Potomac River at Cobb Island, MD	15	N		upland	73-1282
3/27/75	Worchester County Commissioners Show Hill	Pocomoke River near Pocomoke, MD	128	N		landward of MHW shoreline	74-700
3/12/75	Romer, Arthur H. Jr.	Patuxent River near Holland Point, MD	100	N		upland site on applicant's property	73-24
10/10/74	U.S. Navy Commanding Officer, Chesapeake Division, D.C.	Patuxent River at Naval Air Station, MD	700	N	clamshell	landward of MHW shoreline in Patuxent River	74-283
4/15/75	Columbia LNG Corp. Wilmington, Del.	Planters Wharf Creek Lusby, MD	13,900	N	bucket	use of backfill over pipeline	[illegible] 339
4/15/75	Columbia LNG Corp.	Patuxent River near Aquasco, MD	126,640	N	bucket	used as backfill	74-342

TABLE A-29 (concluded)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1975

Date	Permittee	Location	Total Amount Dredged	N M	Method Used For Dredging	Disposal Site	File Number
1/17/75	B.F. Diamond Construction Corp., Inc.	Patuxent River near Johnstown, MD	3,000	N	clamshell	place above MHW shoreline	73-887
3/14/75	Cedar Point Marine	Marshy Creek near Narrows, MD	2,700			deposited and retained on upland area landward of MHW shoreline on applicant's property	73-546
4/7/75	Bowleys Point Yacht Basin	Middle River at Bowleys Point, MD	10			upland site above MHW shoreline	75-241
12/2/74	Village Green, Inc.	Queen Anne found near Mattepex, MD	25,000	M	hydraulic	landward of MHW shoreline on applicant's property	
11/22/74	Tang, Richard	Ramsay Lake at Turkey Point, MD	50		dragline	landward of MHW shoreline	74-324
5/7/75	Northumberland Plantation	Potomac River off Route VA 800	7,000		hydraulic	upland and contained	74-693
2/28/75	Dupont de Nemours	Potomac River near Falling Water West VA	40		dragline	use as fill	73-906
4/17/75	Washington Surburban Sanitary Commission	Potomac River at Mockley Point, MD	40,000		bucket	upland site	74-1058
4/15/75	Columbia LNG Corp.	Potomac River, MD	740,000		bucket	use as backfill	74-343
6/27/75	Reick, Jean E., and Franklin, S.	Port Tobacco River at Port Tobacco, MD	70	N		behind bulkhead	75-3
1/6/75	Wilford, Jonathan	Island Green near Oxford, MD	30			deposited and retained landward of MHW shoreline	74-510
11/18/74	C.S.Y. Finance, Inc.	Patapsco River at Canton MD	98,000			landward of MHW shoreline	74-564
9/3/74	Bethlem Steel Corp.	Patapsco River at Sparrows, MD	dredge			landward of MHW shoreline	73-1260

END OF PRINTED PAGE

TABLE A-30

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1976

Date	Permittee	Location	Total Amount Dredged	N M	Method Used for Dredging	Disposal Site	File Number
5/20/76	LeRoy, Pierre L.	Chesapeake Bay at Rock Hall, MD	1,500	N		used as fill material behind bulkhead	75-1415-1
11/6/75	Steele, Albert R. Jr.	Chesapeake Bay near Matapeake, MD	10,000	N	hydraulic	deposited and retained in a diked area on applicant's property	75-282
10/16/75	Thompson, Herman	Chesapeake Bay at Kent Point, MD	30,000	N	dragline	retained landward of the bulkhead	1
12/5/76	Darney, Edward	Cat Creek and Patuxent River, MD	5,500	N		landward of bulkhead	75-990
9/10/76	Cedarhurst Citizens	Cedarhurst Channel, MD	3,000	N	dragline	approved upland	75-625
8/30/76	Moore, Marshall & Willard	Brannock's Bay, MD	700	M	dragline	used to create a causeway	75-949
9/26/75	Pappa, John	Brannock's Bay, MD	25	N	dragline	landward of shoreline on applicant's property	74-988
9/26/75	Siegman, Raymond H.	Big Annemessex, MD	100	N	clamshell	retained landward	74-399
10/7/75	Baltimore County Dept. of Recreation	Bird River, MD	16,900	N	hydraulic	deposited in bermed area	75-165
4/8/76	Hammermill Paper Co.	Bald Eagle Creek, PA	300	N	dragline	use as fill on the pipe	75-1363
5/10/76	Watergate Village	Back Creek, MD	2,739	N	dragline	680 landward of bulkhead. rest: upland site	75-123-1
1/9/76	Wooster, William		350	N	dragline	upland disposal area	76-0023
9/26/75	Ardmore Developers, Inc.	Assawoman Bay, MD	257	N		landward of bulkhead	74-493
9/28/76	Potomac Electric Power Company	Anacostia River, MD	22,000	N	hydraulic	diked disposal on applicant's property	76-427
7/14/75	Washington Suburban Sanitary Commission	Anacostia River, MD	150,000	N	hydraulic	landward & retained	75-854
10/31/75	Cullen, Reginald	Annemessex Canal, MD	2,106	N	backhoe	upland	75-139
3/29/76	Asplen, S. Herbert	Church Creek, MD	90	N		deposited & retained landward of bulkhead	75-1366
6/4/76	Brice, Tylalin	Chester River near Chestertown, MD	850	N	dragline	truck to an abandoned gravel pit and retained	76-111
7/12/76	Castle Marina, Inc.	Chester River near Chester, MD	1,500	M	hydraulic	deposited and retained in a diked area	76-564
1/15/76	Evering, Joseph	Frog Mortar Creek near Galloway Point, MD	600	M	dragline	upland and retained on applicant's property	75-974
8/15/75	Galloway Creek Marina	Galloway Creek, MD	420	N	dragline	deposited & spread onto open field above MHW shoreline	75-188
10/10/75	Wolfe, Frank	Galloway Creek at Log Point MD	200	N	dragline	deposited behind bulkhead	75-569
11/28/75	Newport Bay Co. Inc.	Gibbs Pond at Sinepuxent Neck, MD	1,200	N		landward of bulkhead in Gibbs' Pond	75-720
7/16/76	Astin, Ira T.	Flag Pond near Ophelia, VA	500	N	dragline		75-1167
4/12/76	Maryland Dept. of Natural Resources	Dundee Creek, MD	1,100	N	dragline or backhoe	upland site	74-1011
1/21/76	Harbour View, Inc.	Elk River near Courthouse Point, MD	2,000	N	suction dredge	upland & retained on applicant's property	75-1005
1/6/76	Fairfax County Department of Public Works	North Fork of Dogue Creek, VA	67	N	dragline	upland disposal area	75-628
3/5/76	Flinchum, Allen J.	Cypress Creek, MD	350	N		Trucked to a commercial dump	75-1314-2
3/17/76	Somerset County	Dames Quarter Creek, MD	33,450	N		retained in designated spoil area	NABOP-F/1
12/8/75	Clarke, Thomas Jr.	Church Creek near Saint Inigoes, MD	60	N	clamshell	fill behind bulkhead	74-114
4/14/76	Townsend, Victor	Chincoteague Bay near Handy Hammock, MD	200	N	dragline	landward of MHW shoreline on applicant's property	76-282
8/13/75	Kibler's Marina, Inc.	Chester River at Chestertown, MD	5,600	M	crane	dump trucks to upland diked area	74-400

TABLE A-30 (continued)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1976

Date	Permittee	Location	Total Amount Dredged	N M	Method Used for Dredging	Disposal Site	File Number
7/29/75	Holland, William M.	Honga River near Church Creek, MD	200	M		retained landward of MHW shoreline	75-260
8/16/76	McMahan, Lee D.	Honga River at Hoopers Island	800	N		landward of bulkhead	75-1439
1/7/76	Bainum, Irwin	Isle of Wright Bay at Ocean City, MD	130	N	dragline	landward of MHW shoreline	75-992
8/19/75	Brown, Paul	Isle of Wight Bay near Ocean City, MD	220	N		landward of MHW shoreline	73-1028
4/16/76	Fisher, William E., Jr.	Isle of Wight Bay at Ocean City, MD	60	N	dragline	landward of bulkhead	NABOP-F/1
3/25/76	Grazier, Kathryn E.	Isle of Wight Bay at Ocean City, MD	6	N	backhoe	landward of bulkhead	75-1155
11/7/75	Hudson, James	Isle of Wight Bay at Cap Isle of Wright, MD	3	N	backhoe	landward of bulkhead	75-836
11/21/75	Lamphier, John O.	Isle of Wight Bay at Ocean City, MD	12	N	clamshell	channelward of MHW shoreline	75-991
7/15/76	Lynch, William H.	Isle of Wight Bay near Ocean City, MD	375	N	dragline or clamshell	landward of MHW shoreline on 2 properties	76-408
3/1/76	Phillips, Bruce R.	Isle of Wight Bay near Ocean City, MD	720	N	clamshell	landward of MHW shoreline	75-946
10/29/76	Hurts Creek Assoc.	Hurts Creek, MD	4,000	N		upland disposal sites	76-796
2/26/76	Bahia Marina, Inc.	Isle of Wight Bay at Ocean City, MD	300	N	dragline	landward of MHW shoreline at Ocean City, MD	75-950
7/14/75	Brown, Kenneth	Johnson Bay near Girdletree, MD	10	N	dragline	landward of MHW shoreline	75-268
9/10/76	Maryland State Dept. of Transportation	Jones Falls, MD	190	N	clamshell	reused for project rest in disposal area upland	76-528
8/13/76	Morris, Marvin K.	Kent Narrows, MD	220	N	dragline	above the MHW shoreline	75-14001
12/12/75	Faulkner, James A.	Knapps Narrows, MD	195	N		landward of bulkhead	73-276
12/5/75	Fluharty's Boatyard, Inc.	Knapps, Narrows, MD Tilghman Island, MD	400	N		deposited & retained on upland site	74-515
6/10/76	Noyes, James B., Jr.	Knapps Narrows at Tilghman Island, MD	210	N	clamshell	landward of MHW shoreline	75-1302
11/28/75	Meyer, Robert C.	Letha Pond near Pasadlina Beach, MD	600	N	clamshell	upland	75-344-1
10/1/75	Eastern Bay Seafood	Little Creek Near Chester, MD	650	N	clamshell	trucked onto upland site	75-62
12/1/75	Daly, Robert E.	Logecliff Harbor, MD	10	N		landward of bulkhead	75-516
5/10/76	Leigh, A.M. & Bond, C.	Magothy River at Gibson Island, MD	600	N	clamshell	landward of bulkhead	75-568
10/14/75	Madgett, A.C.	Magothy River at Longview, MD	75	N	hydraulic	landward of bulkhead	75-214
2/25/76	Maryland State Dept. of Natural Resources	Magothy River at Shore Acres, MD	8,800	N	hydraulic	upland	75-634-1
12/1/75	Adams, Mitchell W.	Marumsco Creek, MD	692	M		upland	75-938
1/28/76	Grove, George D.	Marumsco Creek, MD	50	M		upland & spread in adjacent fields	75-1284
4/26/76	Talbot Co. Sanitary Commission	Miles River near St. Michaels, MD	1,500	N		disposal area landward	75-546
2/19/76	Margaret's Farm	Mill Creek at St. Margarets Farm, MD	965	N		upland	75-888-1
4/12/76	Providence Club	Mill Creek at Providence, MD	760	N	clamshell	upland diked disposal area	75-1123
9/28/76	Ray, Robert N.	Mill Creek near Hollywood	111	N		behind bulkhead	76-176
7/3/75	Turner, Elwood K.	Mill Creek near Harry Hogan Point, MD	1,000	N	dragline	landward of bulkhead	74-1025
12/11/75	White, Martin, C.Jr. and Robert L. Garrison	Pythers Creek at Cape Loch Haven	300	N		landward of bulkhead	75-310-1
9/30/76	Eppard, Leonard C.	Potomac River near Hallowing Point, MD	200	N	clamshell		76-334
1/9/76	City of Alexandria	Potomac River, City of Alexandria, VA	40,000	N		landward of MHW shoreline	75-941

TABLE A-30 (continued)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1976

Date	Permittee	Location	Total Amount Dredged	N M	Method Used for Dredging	Disposal Site	File Number
1/28/76	Crenshaw, R.S. Jr.	Potomac River, City of Alexandria, VA	500	M		landward of MHW shoreline	75-808
8/26/75	Maddox, Fred (Marion Station, MD)	Pocomoke River near Shelltown, MD	90	N		landward of bulkhead	75-267
11/19/75	Wilson, Robert J.	Pocomoke River near Shelltown, MD	2,140	N	hydraulic	landward on applicant's property	74-78
9/24/75	U.S. Navy Dept. of Navy D.C.	Bridge at Indian Head, MD	120	M		landward of MHW shoreline	75-68
1/13/76	St. Mary's County Commission of Leonardtown, MD	Patuxent River, at Kingston and Little K	4,500	M	hydraulic	upland sites until dry, then on beaches	75-1020
3/5/76	Nicholas, J.K., Hilliard, G.T., Bliss, R.R., Poolesville, MD	Peck's Cove near Grasonvill , MD	150	M	backhoe	upland retained	75-1055
5/7/76	Breezy Point Beach	Plum Point Creek near Plum Point, MD	6,000	M	dragline	retained behind earthen dike on applicant's property	74-243
6/3/76	Blades Materials, Inc.	Pocomoke River near Pocomoke City	23,000	N		landward of MHW shoreline on applicant's property	73-905
9/17/76	G.A. & F.C. Wagman, Inc. (York, Pa.)	Middle Branch Patapsco River at Baltimore, MD	140,000	M	clamshell	tucked to diked disposal area on Arundel County property at Masonville	76-717
8/25/76	Baltimore City Dept. of Public Works	Papapsco River at Baltimore City, MD	535	M	dragline	used as cover material	76-536
11/11/75	Baltimore Gas & Electric Company	Patapsco River, MD	6,000	M		upland on applicant's property	75-482
1/9/76	Bethlehem Steel Corp.	Patapsco River, MD	235,000	N	clamshell	spoil site & retained	73-926
7/15/75	Bethlehem Steel Corp.	Patapsco River at Fairfield, MD	1,400	M	clamshell	upland site	75-81
8/27/75	Harbor View Assoc.	Occoquan River & Massey Creek near Lorton, VA	11,000	M	hydraulic	landward of MHW shoreline	75-195
7/22/75	County Commission of Queen Annes County	No Name Creek at Philpots Island, MD	30,500	N	hydraulic	in earthen dike upland	74-1063
12/15/75	Cecil County Dept. of Public Works	Northeast River near Seneca Point, MD	2,000	M	suction	landward of the MHW shoreline on applicant's property	75-495
7/30/76	Dayton, David M.	Nanticoke River at Bivalve, MD	370	M	clamshell	upland on disposal area	76-362
3/25/76	Esham, Ottis G.	Rockawalkin Creek at Salsibury, MD	10,000	N		designated spoil area	71-1213
5/18/76	Burroughs, Ann T.	Severn River at Long Point, MD	260	N	dragline	landward of bulkhead	73-1037
9/4/75	Carter, Elton D.	Severn River at Herald Harbor, MD	400	N	hydraulic	landward of bulkhead	75-411
2/20/76	Point Field Landing, Inc.	Severn River at Point Field Landing, MD	1,250	N	dragline & clamshell	landward of bulkhead	75-448-1
1/17/76	Hain, Klaus H. Dr.	Shipping Creek at Butler's Landing, MD	200	N	clamshell	landward of bulkhead	76-0029
8/9/76	Smith Brothers, Inc.	Slaughter Creek at Taylor Island, MD	590	M		approved disposal site	76-203
10/17/75	Parker, Mary E.	South River at Hillsmere Estates, MD	1,650	N	hydraulic	landward of bulkhead & retaining wall	75-14
10/23/75	Robert Shaw L.B.	South River at Water Beach, MD	55	M	clamshell	deposited & retained landward of existing bulkhead	75-517-4
12/8/75	Annapolis, City of	Spa Creek at the City Dock, Annapolis, MD	2,300	M	clamshell	trucked to Annapolis landfill	75-1028
7/7/76	Ireland, R., Gadow, A. and Saathoff, W.	Spring Cove at Coster, MD	5,000	M	hydraulic	diked spoil are a on applicant's property	76-187
1/15/76	Maryland State Port Administration, Baltimore	Spring Garden Channel, MD	60,000	M	clamshell	hopper barged to diked area upland	75-721

TABLE A-30 (concluded)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1976

Date	Permittee	Location	Total Amount Dredged	N M	Method Used for Dredging	Disposal Site	File Number
7/2/75	J. Lawson Gilbert Distributor, Inc.	Susquehanna River at Havre de Grace, MD	300	N	clamshell	deposited & retained landward	75-27
12/17/75	Borough of Elizabethtown	Susquehanna River near Bainbridge, MD	400	N		upland disposal	74-984
6/29/76	Fulmer, Harry L.	Susquehanna River near Drumore, MD	5,000	N	hydraulic	against shoreline	76-479
11/25/75	Harrisburg, City of	Susquehanna River at Harrisburg, MD	413	N	backhoe	upland site above MHW shoreline	75-592
1/19/76	Metropolitan Edison Company (Reeding, PA)	Susquehanna River at Three Mile Island, PA	3,000	N	suction	in designated upland disposal area	75-1048
9/16/75	Metropolitan Edison Company (Reeding, PA)	Susquehanna River at Three Mile Island, PA	1,000	N	bucket	upland disposal site above MHW mark	75-1048
12/5/75	Mt. Joy Borough Authority	Susquehanna River at Three Mile Island near Chikies Rock, PA	230	N	backhoe	landward of MHW shoreline	75-648
2/19/76	Pennsylvania Dept. of Transportation (Harrisburg)	Susquehanna River at the I83 bridge, PA	120	N	backhoe	on river side	75-1331
9/9/76	Pennsylvania Power & Light Company	Susquehanna River near Berwick, PA	9,600	N		backfill	76-115
9/20/76	U.S. Coast Guard Portsmouth, VA	Stillpond at Kinnaird Point, VA	29,000 1,350 30,350	M	hydraulic	diked area on applicant's property	75-1396
3/5/76	FMC Corporation Agricultural & Chemical Division, Baltimore	Stonehouse Cove at Baltimore, MD	114	N	clamshell	deposited & retained upland on applicant's property landward of MHW shoreline	75-1201
3/9/76	Alexander, Robert V.	Stoney Creek at Clearwater Beach, MD	300	N	dragline	landward of bulkhead	76-0016-1
3/3/76	Wanner, Charles R.	Stoney Creek at Clearwater Beach, MD	1,500	N		landward of bulkhead	75-312-4
8/9/76	Hudson, Walter J. Sr.	St. Martin River near Bishopsville, MD	1,500	M	dragline	landward of MHW shoreline	76-430
3/19/76	Geiger, Edwin P.	St. Mary's River near St. Mary's City, MD	250	M	backhoe or gradall	deposit and retain behind riprap	75-1166
1/9/76	Wanex, Thomas J.	Warwick River at Secretary, MD	350	M	clamshell	retained in upland area	75-693
9/3/75	Washington Metro Transit Authority	Washington Channel off the Potomac River, MD	173,000	N		retained in upland area	73-1208
6/30/76	State of Maryland Dept. of NR Capital Programs Administration	Watts Creek at Martinak State Park, MD	450	N	dragline or backhoe	deposited & retained behind bulkhead	75-727
6/7/76	Delmarva Water Transport Committee, Salisbury	Wicomico River near Salisbury, MD	500	N		designated spoil disposal area	76-301
6/11/76	Brown, Cecil E.	Yeocomico River at Allen Point, MD	20	N	bucket	upland disposal site	76-377
9/22/75	Clarke Joseph M.	Goose Creek at Rumbly	2,500	N	dragline	deposited and retained landward of proposed bulkhead	74-1074
9/24/76	Delmarva Water Transport Community, Inc.	Nenticoke River near Leaford	11,000	M		upland disposal area	76-395
12/9/75	Parks Orville	Shoal Creek at Cambridge, MD	120	N	clamshell	channelward of MHW shoreline	74-858
12/12/75	Gumper Daniel	Linepuxent Bay at Ocean City	2,350	N	dragline	landward of MHW shoreline	75-1001
7/15/75	Shofer Cherly	Brook Creek, MD	63	N		landward of bulkhead	74-620
12/10/75	Amerada Hess Corp.	Curtis Creek near Ferry Point	30,000		clamshell bucket	Frundel Corporation Property at Masonville deposited and retained	75-51
10/27/76	Morrissett John P.	Jones Pond	500		dragline	upland disposal area	76-229

TABLE A-31

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1977

Date	Permittee	Location	Total Amount Dredged	N M	Method Used For Dredging	Disposal Site	File Number
4/18/77	Maryland State Dept. of Natural Resources	Chesapeake Bay near Matapeake, MD	15,000	M		landward of proposed bulkhead	73-134-4
10/18/76	Carpenter, Lloyd	Chesapeake Bay at Taylor's Island, MD	60	N		used as backfill	73-870
11/4/76	Cedarhurst Citizens Association	Cedarhurst Channel, MD	250	N		landward of bulkhead	76-1114-1
1/18/77	Mills, Galen W.	Chapel Creek, MD	1,185	N	dragline	trucked to upland disposal site	76-990-2
8/24/77	Combs, William	Cambridge Creek, MD	5,900	N	dragline and clamshell	upland site	77-0252-5
11/4/76	Bassett, R.T.	Catbird Creek, MD	1,732	N	hydraulic	backfill an existing channel	76-89
7/26/77	Langenfelder & Son	Breton Bay, MD	500		backhoe	disposal area landward of shoreline	76-6671
6/9/77	Porter, Elizabeth	Broad Creek, MD	50	N		retain upland site on applicant's property	76-1222-5
11/12/76	Reale, Salvatore	Bell Creek, MD	430	N	dragline	landward of shoreline	74-808
12/20/76	Tiller, Boyce C.	Black Beard Pond, VA	650	N	dragline	upland disposal site	76-898
8/1/77	Annapolis, City of	Back Creek, MD	850	N		Annapolis landfill	77-0235-1
6/10/77	Zahniser, Albert	Back Creek, MD	60	N	crane	upland disposal site	77-0043-2
8/18/77	Mrs. Mary Clark	Aberdeen Creek, Watermelon Point, MD	48	N	clamshell	upland disposal site	77-00667-1
6/24/77	Maryland Park Service	Annemessex Canal	1,000	N	clamshell or backhoe	diked disposal area	77-0493
11/1/76	Kent Island Limited Partnership	Cove of Chesapeake Bay near Stevensville, MD	160,000	N	hydraulic	upland and retained in applicant's property	74-192
9/28/77	Cloverfield Improvement Association	Chester River at Cloverfield, MD	800	M	dragline	upland spoil site	77-0480-5
10/29/76	Thomas A. Morton, Jr.	Grace Creek at Bozman, MD	375	N	clamshell	upland site	76-0081
8/8/77	Neff, Bill V.	Frog Pond near Ragged Point, VA	400	N		behind bulkhead	75-1364
8/15/77	Travers, Delmas R.	Fishing Creek at Honga, MD	2,500	N		deposited and retained landward of MHWS	76-439
1/5/77	Somerset County Sanitation District, Inc.	Francis GUT at Ewell, MD	200	N	dragline	designated spoil area	76-655-4
7/17/77	Maryland State Dept. of Natural Resources	Elk River, MD	350	N	hydraulic or mechanical	landward of proposed bulkhead	77-0257
5/13/77	Becker, William	Deep Creek, MD	100	N	dragline	upland on the property	77-0096-2
5/9/77	Facilities Engineering (Director of) U.S. Army Corps of Engineers	Dogue Creek, VA	75,000	N	hydraulic	spoil area adjacent to Dogue Creek	76-1336
3/4/77	Donald J. Scylolz & Company	Dogue Creek, VA	6,500	N	hydraulic	upland on applicant's property	73-1214
11/26/76	Powell, Luther	Cypress Creek, MD	40	N		landward of proposed bulkhead	76-647-2
10/14/76	McCormick & Co., Inc.	Crab Alley Bay at Parson Island, MD	5,200	M	hydraulic	retained in dikes on applicant's property	76-404
8/19/77	Jennings, John L.	Combs Creek, MD	25	N	bucket	landward of MHW shoreline at designated spoil site	76-1358
3/18/77	Gullen, Mary	Choptank River at East New Market, MD	3,000	N	clamshell	landward of MLW	76-928
11/15/76	Pioneer Point, Inc.	Grove Creek near Gordon Point, MD	300	N	dragline	barged and trucked to upland site	76-456
3/11/77	J.A. Ammons, Inc.	Herrings Bay at Deale, MD	1,980	N	Crane	in hole dug on property	76-1156-2
4/4/77	Baltimore County Dept. of Public Works	Herring Run at Baltimore City, MD	51,000	M	dragline	uplands and retained by grading & seeding	76-712
4/77/77	Keim, William J.	Honga River near Wingate, MD	3,384	N		create a 14-foot base dike around pond	77-0418
5/9/77	Lampron, Charles F.	Hopkins Creek near Barren Point, MD	3,415	N	dragline	deposited and regained upland on applicant's property	76-539

TABLE A-31 (continued)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1977

Date	Permittee	Location	Total Amount Dredged	N M	Method Used for Dredging	Disposal Site	File Number
9/21/77	Hannum, Frederick V.	Isle of Wight Bay at Ocean City, MD	70	N	clamshell or dragline	landward of MHW on applicant's property	77-0800-1
6/17/77	Insley Wade M. III	Isle of Wight Bay at Cape Isle of Wight, MD	120	N	backhoe	landward of bulkhead	77-0336-1
1/27/77	Leonard, Skinner	Knapps Narrows at Tilghman Island, MD	1,172	N	dragline	landward of mean water shoreline	76-432-3
6/29/77	Phillips, Garland	Knapps Narrows at Tilghman Island, MD	881	N	dragline	deposited on upland site	76-270-3
6/1/77	Phillips, Russel	Knapps Narrows at Tilghman Island, MD	871	N	dragline	landward of bulkhead	76-263-3
11/5/76	Henderson, James M.	Lanes Pond, MD	200	M	backhoe	along beach	76-891
3/28/77	Garlands Association	Le Gates Cover at Oakland, MD	875	N	hydraulic	upland area	76-837-3
6/10/77	Walker, Clyde T.	Lewes Creek, DE	2,000	N		upland above MHW shoreline	75-1373-2
9/30/77	Crisfield, City of	Little Annemessex River, MD	116	M		upland	77-1165-5
5/20/77	Park and Recreation	Little Annemessex River at Crisfield, MD	400	N	dragline	upland disposal area	77-0168-4
7/6/77	Staley, Carl W.	Long Haul Creek, MD	400	N		upland	76-1341-2
8/4/77	Faith Seafood, Inc.	Lower Thorofare at Wenona, MD	500	N		upland	76-443-4
6/21/77	Bayberry Community Association	Magothy River, MD	1,000	N	dragline & hydraulic	diked disposal area	75-1346-2
3/18/77	Eliassen, Teddy	Manokin River at Rumbley, MD	150	N	dragline	upland disposal area #2	76-940
8/12/77	Anne Arundel County Public Works, MD	Marley Creek at Marumdale, MD	8,100	N	clamshell and dragline	trucked to upland disposal sites	76-926-1
8/29/77	PO-PAC Inc.	Marshy Creek near Grasonville, MD	780	N		trucked and deposited upland	77-0288-4
1/5/77	Somerset County Sanitary District, Inc.	Merlin Gut near Tylerton, MD	50	N	dragline	landward of bulkhead	76-534-4
10/7/76	Bowleys Point Yacht Basin	Middle River at Bowley's Point, MD	45	N	suction	landward of MHWS. then upland to disposal site	76-599
10/21/77	Bittort Ford Sales Inc.	Miles River & Hambleton Cove, MD	2,320	N	hydraulic MUD CAT	upland landward of bulkhead	77-0565-5
2/28/77	Bozman, Wayne	Mine Creek at Frenchtown, MD	466	M		deposited and retained upland	76-1008-4
2/17/77	Wright, Edwin E.	Ramsey Lake off South River, MD	60	N	dragline	landward of proposed bulkhead	76-890-2
4/22/77	Town of Dumfries	Quantico Creek at Dumfries, VA	607	N		landward of MHW shoreline	76-145
11/2/76	Robinson Terminal Warehouse	Potomac River at Alexandria, VA	200	N	clamshell	deposited at Rainwater landfill	75-1334
3/29/77	U.S. Navy	Potomac River at Quantico, VA	85,000	N	hydraulic	landward of MHW shoreline	76-896
7/18/77	Garden, Gerbert C.	Potomac River at Lynch Point, VA	3,500	N		upland	77-0276
2/2/77	Denison, Robert	Price Creek at Queen Anne Colony, MD	40	N		landward of bulkhead	76-502-5
8/12/77	Hansel, Lawrence G.	Prices Creek near Kentmorr, MD	200	M	dragline or clamshell	upland spoil site	77-0278-5
3/7/77	Williams, Winnie	Pocomoke River near Pocomoke City, VA	30	N		landward of MHW shoreline	76-1193-2
5/10/77	Poole, Richard E.	Poole's Pond at St. George Island, MD	180	M	dragline	behind 2 adjacent bulkheads	76-911
8/15/77	Bowie, Howard N. (La Plata)	Port Tobacco River at Warehouse Point, MD	600	N		landward of bulkhead	73-1210
5/23/77	Pingitore, Vincent	Potomac River at Harry W. Nice Memorial Bridge, MD	275	N			77-0161
7/26/77	Stewart Investment Company (D.C.)	Piney Point Creek at Piney Point, MD	1,000		dragline	disposal area landward of MHW Shoreline	76-678
7/11/77	Lowery, Orem	Patuxent River at Broome Island, MD	900	N	dragline	upland	76-315-1
10/29/76	Maryland Dept. of Transportation (Baltimore)	Patapsoc River at South Locust, MD	900,000	N		barged and trucked to upland diked disposal area	75-665
6/27/77	Maryland Dept. of Transportation (Baltimore)	Patapsco River at Dundalk Marine Terminal, MD	24,000	M	bucket	Arundel Corp. property at Masonville, diked	77-0550
12/9/76	Bethlehem Steel Co.	Patapsco River at Sparrows, MD	21,000	M		diked area	76-981
4/21/77	Baltimore City Dept. of Public Works	Patapsco River at Baltimore City, MD	230	N	suction dredge	barged to an upland diked disposal area	77-0018

TABLE A-31 (concluded)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1977

Date	Permittee	Location	Total Amount Dredged	N M	Method Used for Dredging	Disposal Site	File Number
8/26/77	Baltimore Gas & Electric Company	Patapsco River near Orchard, MD	110,000	N	hydraulic	upland settling basin	77-0421-2
2/14/77	Agrico Chemical Co.	Patapsco River at Baltimore, MD	11,000	M	clamshell	diked disposal area	76-1090
3/6/77	Kreuse, Richard	Occoquan River at Occoquan, VA	1,000	N	clamshell	upland	77-0554
10/18/77	Mimose Cove & Tyler Deale Civic Assoc.	Parker Creek near Deale, MD	13,800	N	hydraulic	in existing lagoon	77-0535-1
7/20/77	Abner, Robert F.	North Beach, MD	335	N	dragline & clamshell	upland site of applicant's property	77-0099-1
1/20/77	Ellett, J.H.	Nanticoke River near Seaford, MD	177	N		landward of bulkhead	76-588-2
7/5/77	Karamian, Sarbik A.	Nanticoke River near Sandy Hill, MD	270	N		beach replinishment	75-11154
6/31/77	Lambert, Frank Jr.	Nanticoke River at Seaford, MD	2,155	N	dragline	deposited & retained landward of bulkhead	76-1344-5
2/2/77	Townsend, Victor	Newport Bay near Handy Hammock, MD	1,060	M		landward of MHW shoreline on applicant's field	76-1349-1
3/24/77	Maryland State Dept. of Natural Resources	Rockhold Creek at Deale, MD	17,000	N	hydraulic	upland disposal	NABOP-F/1-1
7/1/77	U.S. Navy Commanding Officer	Second Cove Patuxent River, MD	100,000	N	clamshell	upland dike disposal area	76-307-1
7/20/77	Lassahn, Edgar F.	Seneca Creek, MD	30	N	clamshell	landward of bulkhead on applicant's property	77-0259
3/11/77	Rugby Hall Community Association (Arnold, MD)	Severn River at Arnold, MD	700	N	hydraulic		76-1353-2
10/21/76	Cropper, George B.	Sinepuxent Bay at Ocean City, MD	2,360	N		landward of MHW	76-0008
10/8/76	Eagles Nest Corp.	Sinepuxent Bay near Coffin Point, MD	55	N	clamshell	landward of MHW shoreline on applicant's property	76-494
10/21/76	Dorchester County Highway Dept. (Cambridge)	Slaughter Creek at Taylor Island, MD	37,000	N	hydraulic	upland	76-44
8/10/77	Allan, Scott H.	Spa Creek, Annapolis, MD	140	N	crane or bucket	landward of bulkhead	77-0125-11
7/15/77	Annapolis, City of	Spa Creek at Fifth Street, MD	150	N	clamshell	Annapolis Sanitary landfill	77-0318-1
8/2/77	Tillman, Irvin C. Sr. (Baltimore)	Swan Creek near Rock Hall, MD	1,200	N	clamshell	landward of MHW shoreline on applicant's property	77-0002-1
8/19/77	Lumpkins Seafood	St. George Creek near Piney Point, MD	1,900	N	clamshell	landward of MHW shoreline	77-0508
5/26/77	Edwards, Alvin R. (Accokeek, MD)	St. Jerome Creek near Dameron, MD	350	N	dragline	landward of MHW shoreline	76-845
8/18/77	Dorchester County Highway Dept. (Cambridge)	Tar Bay at Hoopers Island, MD	3,333	N	dragline	adjacent uplands	77-0630-4
8/19/77	Chesapeake Division Naval Facilities (Salisbury, MD)	West Patuxent Basin at Engin. Command Naval Air Station, MD	12,900	M	hydraulic	designated disposal site landward of MHW Shoreline	77-0236
5/9/77	Griffith, John B.	West River & South Creek near Avalon Shores, MD	3,000	N	hydraulic	upland diked & disposal site	77-0022-1
6/24/77	Bright, Cooper	Brannock's Bay	909	M		adjacent uplands	77-0201
12/20/76	Hall, Richard	Fyres Creek	4,000	N	dragline	landward on appl. property	76-969-1
9/29/77	U.S. Navy	Chesapeake Bay at Hot Point	55	N		landward of MHW shoreline	77-0820
7/14/77	Queen Finnes Co.	Chester River at Love Pt.	200	N		trucked to upland site	77-0093-2
7/20/79	Thenk, Ronald F.	Gunpowder River	15	N	backhoe		78-1060-3
10/18/76	Fronheiser Robert L.	Northeast River	600	N	hydraulic	landward of MHW shoreline uplands	79-0211
5/26/77	Somerset bounty Dept. of Parks and Recreation	Wicomino River near Mount Vernon	70		clamshell	upland disposal area	77-426-4

TABLE A-32

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1978

Date	Permittee	Location	Total Amount Dredged	N M	Method Used for Dredging	Disposal Site	File Number
12/6/77	Tolchester Marina	Chesapeake Bay at Tolchester, MD	4,000	N	dragline	used as fill material	75-1197
2/22/78	Smith, Kenneth	Chapel Creek, MD	150	N		upland	77-1394-4
8/30/78	Jackson, Murray, E.	Cherry Cove & Benton Bay, MD	1,200	N	dragline	in designated spoil area	78-0103
12/16/77	Shaefer, William & Helen	Canoe Neck, MD	45	N	dragline	landward of mean high water shoreline	77-155
1/13/78	Plensoen, Louis M.	Brdige Creek, MD	8,000	M	hydraulic	upland diked disposal site	78-0067-5
9/12/78	Jones, Russell	Broad Creek, MD	2,489	M	dragline	landward of shoreline on applicant's property	78-0808-1
11/3/77	Dorchester County Commissioners	Brooks Creek, MD	3,702	N		behind bulkhead and upland	77-156-4
11/17/77	Marshall, Percy	Big Annemessex, MD	1,000	N			77-1077-4
2/14/78	Birney, Arthur A.	Back Creek, MD	2,000	N	clamshell	upland on applicant's property	77-1222-1
3/9/78	Celmer, Andrew J.	Back River, MD	400	N	dragline	retained landward on applicant's property	73-324-1
10/14/77	Nelson, Woodrow	Back Creek, MD	447	N		landward of bulkhead	77-0033-5
1/11/78	Sterling, Howard	Annemessex Canal, MD	98	N		upland on applicant's property	78-0068-1
1/16/78	Glen Oban Community Association	Asquith Creek, MD	3,160	N	hydraulic		77-1162-2
5/9/78	Hacking, Edward G.	Assawoman Bay, MD	100	N		landward and upland adjacent to dredged area	77-1219-1
1/4/78	Ocean City, Mayor & Council	Assawoman Bay, MD	600	N	dragline	upland to indicated spoil area	77-0816-1
9/1/78	Mr. Charles Gordon, Wetheridge Estates, Inc.	Aberdeen Creek, MD	150	N	bucket	upland	78-0522-2
12/23/77	Tower Gardens Improvement Association, Inc.	Chesapeake Bay & Carter Creek near Romancoke, MD	100	N		on adjacent beach	77-1131-5
8/9/78	Constantine, N.J.	Glebe Bay at Edgewater, MD	100	N	clamshell	upland site	78-0549-1
9/8/78	Goose Bay Marina	Goose Creek near Brentland, MD	20,000	N	dragline	landward of MHWS	78-0064
10/10/77	Baltimore County Dept. of Public Works	Greenhill Cove at Edgemere, MD	1,190	N	dragline or clamshell	used as stock piles	77-0684
12/6/77	Van Dyke, Roger	Gary Creek near Lloyds, MD	50	N		trucked to upland site	77-0587-2
8/24/78	Sprinkle, Edwin G.	Fishing Creek at Windmill Point, MD	55	N		landward of mean high water shoreline	78-0431-4
4/12/78	Tolley, Kathryn T.	Fishing Bay, MD	600	N		on tide bank adjacent to ditch	77-1377-4
7/1/78	Mallan, Thomas A.	Fairlee Creek, MD	1,673	M	dragline	landward of proposed earth berm	78-0069-5
9/21/78	Meredith, Calvert	Farm Creek, MD	800	M		on adjacent upland	78-0776-4
10/27/77	Tolley, Calvert B.	Farm Creek, MD	2,000	M		deposited & retained landward of MHW shoreline	76-1005-7
5/16/78	Pokorny, Joseph K.	Fenwick Ditch at Ocean City, MD	2,000	N	clamshell	landward of MHW shoreline	77-1239-1
3/24/78	Cooper, Grover C.	Fishing Creek near Woolford, MD	200	N	clamshell or dragline	deposited & retained landward of bulkhead	77-1054-5
7/28/78	U.S. Naval Facilities, Engineering Command	Dorsey Creek, MD	300	N	dragline	Annapolis landfill	78-0502-1
2/23/78	Kemp, Mildred T.	Eastern Bay near Wades Point, MD	265	M		upland site	77-1365-5
4/14/78	Baldwin, Thomas	Deep Creek, MD	3,000	N	clamshell	upland	73-21
12/6/77	Harrison, Levin F., III	Dogwood Cove, MD	1,440	N	clamshell	upland spoil site	77-107305
2/23/78	Harrison, Levin F., III	Dogwood Cove, MD	350	M	clamshell and dragline	upland diked spoil site	77-1428-3
10/13/77	Ecklesdafer, John G.	Cypress Creek, MD	100-150	M		landward of an adjacent property	77-0041

TABLE A-32 (continued)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1978

Date	Permittee	Location	Total Amount Dredged	S M	Method Used for Dredging	Disposal Site	File Number
7/30/78	Fair Oaks Community Association	Cold Spring Cove, Cattail Creek, MD	4,000	N	clamshell	upland site	77-0100-1
8/4/78	Brown, Harden M.	Combs Creek, MD	150	N	bucket	retain the spoil material landward of MHW shoreline	77-1385
4/11/78	De Stephano, Robert	Cool Spring Cove at Winchester Farms, MD	300	N	clamshell	landward of the bulkhead	76-876-2
12/6/77	Whaley, Richard C.	Church Creek, MD	45	N	dragline & bucket	upland	75-159-1
10/6/77	Keene, Robert H.	Church Creek, MD	440	N		upland	77-0870-4
10/21/77	Dorchester County Highway Dept.	Choptank River, MD	1,100	N	dragline	upland disposal site	77-629-4
3/31/78	Dorchester County Highway Dept.	Choptank River, MD	17,100	N	hydraulic	upland disposal site	77-1442-4
11/9/77	Dorchester County Highway Dept.	Choptank River, MD	3,888	N	dragline	barged to disposal area	77-847-4
4/28/78	Herring Bay Partnership	Herring Bay at Deale, MD	11,700	N	hydraulic	upland	77-1286-2
8/31/78	Parks Brothers	Honga River at Hoopersville, MD	2,000	N		adjacent upland	78-0547-4
3/31/78	Engerman, Kenneth	Hunting Creek near Hurlock, MD	100	N	clamshell	upland	77-1388-1
1/16/78	Russell, Francis J.	Island Creek at St. George Island, MD	1,000	N	dragline	landward of MHWS upland disposal area	77-1049
2/22/78	Skyline Development Corporation	Isle of Wight Bay at Ocean City, MD	2,000	N	backhoe	landward of bulkhead	77-0406
11/9/77	Somerset County Dept. of Recreation & Parks	Jenkins Creek at Crisfield, MD	19,000	N	hydraulic	upland sites, 3	75-1410
6/23/78	Wilson, Sam	Knapps Narrows at Tilghman, MD	1,000	N		upland site	78-0085-2
3/8/78	Crouch, Hodges	Langford, Creek, MD	2,630	N	hydraulic	upland disposal	76-1351-4
1/5/78	Birdsong, H. Saxon	Leason Cove, MD	50	N	dragline	upland	77-0226-1
8/10/78	Maryland Dept. of Natural Resources	Little Annemessex River at Crisfield, MD	20,500	N	hydraulic	spoil disposal site	78-0543
10/13/77	Somerset County Park and Recreation	Little Annemessex River at Crisfield, MD	800	N	dragline and/ or clamshell	adjacent upland	77-0883-4
2/7/78	Somerset County Park and Recreation	Little Annemessex River at Crisfield, MD	12,000	N	hydraulic	upland disposal area	77-1360-4
9/21/78	Malkus, Calvin	Little Blackwater near Cambridge, MD	250	N		landward of bulkhead	78-0710-4
11/16/78	Garden Estates, Inc.	Little Choptank near Madison, MD	950	M	hydraulic	upland disposal area	78-0863
12/14/77	Anne Arundel County Public Works	Magothy River near Severn Park, MD	2,300	N	hydraulic	upland disposal area	77-1088-2
11/21/77	Boise Cascade Recreation	Manklin Creek at Ocean Pines, MD	31,000	N	dragline or clamshell	landward of existing bulkhead	77-1059-1
11/14/77	Bowleys Point Yacht Basin	Middle River at Bowleys Point, MD	12,000	M	clamshell	disposal area upland	76-1449
3/7/78	Birchwood Improvement Association	Mill Creek at Birchwood, MD	3,450	N	hydraulic	diked disposal area	76-0418-1
2/10/78	Gatti, Louis A.	Mill Creek near Drum Point, MD	170	N	hydraulic	landward of bulkhead	77-1170-1
9/5/78	O'Meara, John	Mill Creek at Lusby, MD	40	N		landward of bulkhead	78-0442-2
7/10/78	Centreville, Community of	Mill Stream at Centreville, MD	500	M	dragline	upland site	78-0408-5
1/24/78	Ely, Nathaniel J.	Mine Creek at Frenchtown, MD	305	M	dragline	adjacent spoil disposal area	76-1416-4
6/19/78	Oak Harbor Marine, Inc.	Rock Creek near Pasadena, MD	1,850	N	clamshell	landward of bulkhead	78-0017-2
11/4/77	Washington Suburban Sanitary Commission	Rock Creek at Forest Glen Park, MD	350	N		use for bank stabilization	77-0736
9/7/78	The County Commissioners of Kent County	Rock Hall Harbor at Rock Hall, MD	752	N		trucked to upland disposal site in Rock Hall	78-0155-1
3/7/78	Willis, William	Rock Hall Harbor at Rock Hall, MD	2,500	N	clamshell	upland site	77-1427-2

TABLE A-32 (continued)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1978

Date	Permittee	Location	Total Amount Dredged	N M	Method Used for Dredging	Disposal Site	File Number
5/30/78	Kleis, Thomas J.	Prices Creek near Stevensville, MD	160	N	clamshell	landward of bulkhead	78-0179-4
5/23/78	Santmyer, Robert	Prices Creek near Stevensville, MD	170	N	clamshell	landward of bulkhead	78-0180-4
3/29/78	Kerge, Jack R.	Ramsey Lake, Edgewater, MD	3,300	N	clamshell	upland	77-0657-2
7/21/78	Fairfax County Water Authority	Potomac River upstream Loudoun County, VA	1,700	N		upland	76-1126
7/21/78	Washington Suburban Sanitary Commission	Potomac River upstream at Walkins, Island, VA	5,300	N		upland on applicant's property	76-804
12/12/77	Matthews, Samuel C. Jr.	Pocomoke River near Shelltown, VA	1,480	N		upland	77-1026-4
10/26/77	Morsell, William	Pocomoke River at Marion Station, VA	720	N		upland	77-1027-4
3/8/78	Young George E. Jr. (Marion)	Pocomoke River near Shelltown, VA	1,800	M		landward of MHW shoreline in Pocomoke River	73-771
7/3/78	Hicks, Wayne & Phillis	Patuxent River at Benedict, VA	60	N	clamshell	landward of MHW shoreline	78-0418
6/6/78	Shell Oil Company	Patapsco River near Wagner's Point, MD	13,000	M	clamshell	barged to and deposited & retained in an upland diked disposal area on Arundel County property at Masonville	78-0265-5
5/19/78	Maryland Dept. of Transportation	Northwest Branch of Patapsco River, MD	25,400	M	clamshell	barged and trucked to upland diked disposal area	78-0255-5
5/19/78	Maryland Dept. of Transportation	Northwest Branch of Patapsco River, MD	36,000	M	clamshell	barged and trucked to upland diked disposal area	78-0212-5
5/19/78	Maryland Dept. of Transportation	Northwest Branch of Patapsco River, MD	59,600	M	clamshell	barged and trucked to upland diked disposal area	78-0252-5
11/18/77	Bethlehem Stell Co.	Patapsco River at Baltimore Harbor, MD	24,500	M		upland	77-1133
6/13/78	Canton Company of Baltimore, MD	Patapsco River at Baltimore City, MD	12,500	M	bucket	diked disposal area	78-0169-5
6/12/78	Gold Bond Building Products	Patapsco River at Canton Railroad Yard, MD	13,500	M	clamshell	upland diked disposal	77-1446-5
6/26/78	Baltimore, City of, Dept. of Recreation & Parks	Middle Beach of Patapsco River, MD	300	N	dragline or clamshell	upland disposal deposited and retained	78-0090-6
6/9/78	Maryland State Highway Administration, Baltimore	Paint Branch near College Park, MD	330	N		spoil used for embankments	77-1337
10/18/78	Mimosa Cove & Tyler Deale Civic Assoc.	Parker Creek near Deale, MD	13,800	M	hydraulic	in existing lagoon	77-0535-1
12/19/77	Berger, William S.	Northeast River at Northeast, MD	110	N		landward of bulkhead	77-1033-2
5/22/78	Cecil County Dept. of Public Works	Northeast River at Charlestown, MD	2,800	M	dragline	on adjacent uplands	76-669
4/6/78	Beach, Mary J.	Occoquan River near Lorton, VA	2,000	M	clamshell	upland	77-0891
5/18/78	Horner, H. Louis	Nanticoke River near Tyaskin	700	M	clamshell	adjacent road	77-0680-4
10/24/77	Hill, Donald C.	Neabsco Creek near Woodbridge, VA	300	N			77-0205
10/27/78	Shymansky, Bruce	Neale Sound near Cobb Island, MD	200	M	clamshell	landward of bulkhead	77-1052
7/18/78	Hargest, Elmore	Severn River at Crownsville, MD	980	N		fill behind bulkhead	78-0855-2
5/31/78	Dreams Landing Condoiniums Owners' Assoc.	Severn River at Dreams Landing, MD	6,400	M	clamshell	upland	77-0055-1
4/26/78	Petty, Denzil M.	Severn River at Winchester on the Severn, MD	1,020	N	clamshell	landward of bulkhead	77-0524
6/13/78	Winchester Pond Property Owners	Severn River at Winchester MD	500	N	clamshell	upland site	78-0365-1
6/9/78	Hunters Harbor Civic & Recreation Assoc. MD	Sillery Bay near Hunters Harbor, MD	12,000	N		some (150 cu yd) used as landfill. rest upland	75-234

TABLE A-32 (concluded)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1978

Date	Permittee	Location	Total Amount Dredged	N M	Method Used for Dredging	Disposal Site	File Number
6/1/78	Miami Court Motel	Sinepuxent Bay at Ocean City, MD	300	N		landward of bulkhead	78-0181-2
3/23/78	Wetherill, Frederic (Pennington, N.J.)	Slaughter Creek at Taylor Island, MD	3,000	N		used to construct a diked around the pond	77-1363-4
5/16/78	Coady, Charles P.	Slaughter Creek near Royal Oak, MD	350	N	clamshell or hydraulic pipeline	landward of existing bulkhead	78-0183-5
7/25/78	U.S. Coast Guard	Somers Cove at the U.S. Coast Guard Station at Crisfield, MD	250	N	dragline or clamshell	upland	78-0393-1
1/31/78	Annapolis Yacht Sales & Service	Spa Creek between 5th and 6th St., MD	520	N	dragline or clamshell	upland site	77-0860
11/22/77	Maryland State Dept. of Natural Resources, Annapolis	Spa Creek at Annapolis, MD	350	N	clamshell	Annapolis landfill	77-0495-1
11/30/78	Selinsgrove Municipal Authority	Susquehanna River near Selinsgrove, MD	995	N	backhoe	redeposited in the trench, excess upland	78-0033-3
6/27/78	Wrightsville Water Supply Company (Harrisburg, PA)	Susquehanna River at Wrightsville, PA	11	N	backhoe	redeposited in trench	78-0009-3
12/5/77	Pa. Fish Commission (Bellefonte, PA)	Susquehanna River near McKees Half falls, PA	150	N		retained on applicant's property	77-1089
11/21/77	Marco Hunting and Fishing Club	Stansbury Creek near Wilson Point, MD	650	N		retained in berms upland	76-1314
2/17/78	Maryland State Dept. of General Services	St. Mary's River near St. Mary's City, MD	50	N		landward of riprap	76-1209
6/15/78	Chesapeake Bay Maritime Museum	St. Michael's Harbor at St. Michasels, MD	650	N	clambucket	landward of museum	78-0177-3
9/29/78	Brown Robert C.	St. Patrick's Creek near Avenue, MD	185	N	clamshell	behind bulkhead	77-1226
6/15/78	Sabatini, Robert	St. Leonard Creek at White Sands, MD	1,000	N	hydraulic	upland of marsh area	77-1398-2
12/16/77	E.H. Dickinson Co., Inc., Baltimore	Tar Bay at Hoopers Island, MD	156	M		upland	77-1057-4
11/22/77	Queen Anne's County Dept. of Public Works Centreville, Maryland	Thompson Creek near Stevensville, MD	1,500	N		upland landfill site	77-1041-1
5/22/78	Essex Seafood, Inc.	Wenona Harbor and lower Thorofare at Wenona, MD	3,125	M	hydraulic	adjacent diked disposal area	78-0419-5
3/28/78	West River Marina	West River at Galesville, MD	2,200	N	clamshell	upland site	77-0685-1
4/4/78	White Hall Yacht Yard, Inc. Annapolis	White Hall Creek near Annapolis, MD	49	N	clamshell	landward of bulkhead	78-0015-1
8/21/78	F.O. Dean Boatyard (Wingate, MD)	Wingate Creek near Wingate, MD	900	N	dragline	behind bulkhead in previously used spoil area	78-0108-4
8/17/78	Kilby, Herndon G.	Wye River near Bennett Point, MD	5,000	N	dragline	upland	77-0520-4
12/6/77	Wilson, Robert J.	Colbourn Creek	345		clamshell	adjacent upland	75-376
5/19/78	Md. Dept. of Transportation	Northwest Branch of Patapsco River in Baltimore Harbor	13,000	M	clamshell	barged and trucked to disposal area	78-0256-5
11/30/78	Selings grove municipal Authority	Susquehanna River near Selinsgrove, MD	995		backhoe	redeposited in the trench excess uplands	78-0033-3

TABLE A-33

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1979

Date	Permittee	Location	Total Amount Dredged	N M	Method Used for Dredging	Disposal Site	File Number
6/18/79	Maryland State Dept. of Natural Resources	Chesapeake Bay at Matapeake, MD	50	N	clamshell		79-0186
9/17/79	Queen Annes County Dept. of Public Works	Chesapeake Bay at Kent Island, MD	40,000	N	mechanic or hydraulic	Kent Island dump site	79-0204
4/2/79	Stinnett, Inc.	Chesapeake Bay at Chesapeake Beach, MD	1,400	M	clamshell	upland	78-1351
2/5/79	Ransome, P. Allen Jr.	Chesapeake Bay near Golden Hill, MD	1,000	M		adjacent to the channel	78-0716-4
12/8/79	Berube, Paul	Chesapeake Bay at Havre de Grace, MD	3,250	N	clamshell	within breakwater	78-1117-1
12/12/78	Concord Cove	Chesapeake Bay at Havre de Grace, MD	11,183	N	hydraulic	upland site	78-1109-1
11/16/78	Havre de Grace, City of	Chesapeake Bay at Havre de Grace, MD	14,000	N	hydraulic	upland diked disposal area	78-0854-1
8/27/79	Schumann, George & Julia	Caine Woods Canal, MD	20	N	dragline or clamshell	landward of proposed bulkhead	79-0358
3/8/79	Bohemia River Marina	Bohemia River, MD	110	N	mechanically	upland owned by applicant	78-1064
6/13/79	Baltimore County Dept. of Recreation & Parks	Bird River, MD	5,500	N	hydraulic	piped to upland disposal	78-1214-3
3/2/79	Jabin, Bert	Back Creek, MD	850	N	clamshell	upland	78-1332-2
8/22/79	A & G Enterprises	Back Creek, MD	450	N	clamshell	landward of bulkhead	78-1107-2
8/27/79	Zahniser, Albert	Back Creek, MD	4,500	N	hydraulic	landward of bulkhead	79-0127-1
3/9/79	Spring Cove Marina	Back Creek, MD	2,375	N	dragline or clamshell	channelward of MHW shoreline	78-0936-2
5/7/79	Reese, Richard	Annemessex Canal, MD	100	N	clamshell	landward of bulkhead	78-0979
5/7/79	Bernstein, Howard	Assawoman Bay, MD	2,100	M	mechanical	landward of bulkhead on applicant's property	78-1346
9/14/79	Ocean Development Corp.	Assawoman Bay, MD	3,000	M	dragline	landward of bulkheads	79-0627
6/20/79	Washington Suburban Sanitary Commission	Anacostia River, MD	110,000	M	hydraulic & dragline	upland and retained	78-0864
3/7/79	Washington Suburban Sanitary Commission	Anacostia River, MD	150,000	N	hydraulic	landward & retained	75-854
9/28/79	Wyatt, Earl	Goose Creek at Toddville, MD	321	M		on tide bank	79-0575
8/11/79	Delmarva Power & Light Company	Goose Pond and Assawoman Bay, MD	33,000	N	dragline or clamshell	use as backfill	78-1004
3/2/79	J.W. Green Construction	Grays Creek at Pasadena, MD	1,250	N	clamshell		78-1268-3
7/20/79	Miller, Rendal, K.	Greys Creek near Ocean City, MD	1,250	N	mechanical	on existing spoil band and landward of MHWS on applicant's property	79-0099
10/27/78	Hulleu, Andrie	Gary Creek, MD	180	N		upland	78-0846
9/28/79	Lloyds Volunteer	Gary Creek at Lloyds, MD	10	N	mechanical	upland site owned by applicant	79-0447
9/28/79	Harford County Dept. of Recreation & Parks	Harford County Dept. of Recreation and Parks	7,000	N	hydraulic	upland site	78-1382-1
11/23/79	City of Alexandria, VA	Four Mile Run in Alexandria, VA	10,000	M	dragline		76-0028
10/26/78	Kellam- Lynwood T.	Fishing Creek at Chesapeake Beach, MD	1,000	N	clamshell & dragline	trucked upland	78-0313
3/22/79	Harrison, Levin	Dogwood Cove, MD	840	N	clamshell	upland diked disposal	78-1068
7/29/79	L.E.G. Joint Venture & Cape Arthur Improvement Association	Cypress Creek, MD	200	N	clamshell	dredged material to be spread on sand beach at property	79-0216
1/25/79	U.S. Gypsum Co.	Curtis Bay near Sledds Point, MD	100,000	M	clamshell bucket	barged to upland disposal site at Marley Neck & retained	78-1137
8/3/79	Krida, Robert H.	Cool Spring Cove, Winchester on the Severn, MD	110	N		upland on applicant's property	79-0225-6

TABLE A-33 (continued)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1979

Date	Permittee	Location	Total Amount Dredged	N M	Method Used for Dredging	Disposal Site	File Number
8/20/79	St. Mary's County Commissioners	Cooper Creek, MD	2,800	N	hydraulic	disposal area upland	78-0261
7/7/79	Western Electric Co.	Colgate Creek, MD	57,000	N	clamshell	upland site at Marley Neck	78-0963-1
5/9/79	Western Electric Co.	Colgate Creek, MD	103,000	N	clamshell	transported to an upland disposal site & retained	78-1063-3
9/28/79	City of Cambridge	Choptank River, MD	3,200	N	hydraulic	contained upland disposal	79-0598
9/12/79	Applegate, Kenneth P.	Choptank River, MD	2,700	N	mechanical		77-1071
9/7/79	Pierce, Malvin	Choptank River, MD	110	N	dragline	landward of existing bulkhead	79-0448
1/22/79	Maryland State Dept. of Transportation	Choptank River, MD	1,000	N		backfill the trench	78-0962
10/4/78	Dorchester County Highway Department	Choptank River, MD	6,000	M		upland disposal area	78-0544-4
1/22/79	Blackwater Farms	Chicamacomino River, MD	95	N		upland	78-1258-4
2/8/79	Brown, Kenneth L.	Chincoteague Bay, MD	15	M	dragline	adjacent road	78-1252
12/20/78	Abramson, Joel	Gunpowder River, MD	25	N		deposited and retained landward of MHWS	78-0949-3
10/3/78	Ransome, P.	Honga River near Golden Hill, MD	900	N		upland	78-0717-4
11/15/78	Alexandria Sanitation	Hoof Run, Alexandria City, VA	16,000	N	clamshell	upland behind earthen berm	78-0510
4/27/79	Calvert County Commissioners	Hungerford Creek near Coster, MD	2,300	N	hydraulic	upland	78-0839-2
10/27/78	Ingleton Association, Inc.	Hunting Creek at Ingleton, MD	900	N	clamshell or hydraulic	deposited & retained landward of MHWS on applicant's property	78-0317
12/21/78	Reynolds, Hugh W.	Island Creek at Hambleton, MD	5,800	N	hydraulic	landward on applicant's property	78-0782
6/13/79	U.S. Coast Guard	Isle of Wight Bay at Ocean City, MD	5,000	N	clamshell	upland disposal areas	78-1095
2/16/79	C & T Land, Inc.	Jackson Creek at Grasonville, MD	900	N	dragline	upland disposal site	78-0003-5
9/18/79	Reeser, Henry	Knapps Narrows at Tilghman Island, MD	90	N	clamshell	upland	79-0201
11/16/78	Garden Estates, Inc.	Little Choptank near Madison, MD	950	M	hydraulic	upland disposal area	78-0843
6/26/79	Brinsfiled, Balvin	Marshyhope Creek near Hurlock, MD	122	N		adjacent uplands	79-0386
1/5/79	Coggeshall, Lester L.	Rewastico Creek near Quantico, VA	300	M		upland	78-1180
10/6/78	Lowe, Samuel C.	Prices Creek at Queen Annes Colony, MD	130	N	clamshell	upland portion of applicant's property	78-795-5
11/19/78	W.A. Thomas & Sons Inc.	Prospect Bay at Kent Narrows MD	100	N		landward of MHW shoreline on applicant's property	75-1207
8/20/79	Maryland Dept. of Natural Resources	Potomac River at St. Clements Island, MD	2,500	N	clam bucket	landward of MHW shoreline	79-0167
3/19/79	The Crenshaw Company	Potomac River at Alexandria, VA	250	N			78-1007
5/17/79	Brownley, R.W.	Pocomoke River near Shelltown, VA	950	M		upland adjacent to canal	78-1355
9/19/79	The Chesapeake Corporation of VA	Pocomoke River near Pocomoke City, MD	23,800	M	clamshell	upland landward of MHW shoreline	79-0380
5/15/79	Bandwarth, Robert F.	Port Tobacco Creek, MD	160	M	dragline	spoil area landward of MHW	79-0054
11/13/78	Mistar Yachts, Inc.	Patuxent River at Hoopers Neck, MD	450	N	dragline	upland	78-0441-1
6/22/79	Ritchie, David	Plum Creek at Breezy Point, MD	250	N	dragline	landward of bulkhead	78-1376-1
2/21/79	Eisenman, Richard (Dunkirk, MD)	Patuxent River at Ferry Landing Woods, MD	5,000	N	hydraulic	upland of applicant's property	74-853
11/30/78	Maryland Dept. of Transportation	Northwest Branch Patapsco River near Hawkins Point, MD	800,000	N		barged and trucked to upland diked disposal area	78-0972

TABLE A-33 (continued)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1979

Date	Permittee	Location	Total Amount Dredged	N M	Method Used for Dredging	Disposal Site	File Number
9/13/79	Canton Elevator Division - CSY Finance, Baltimore	Patapsco River near Lazaretto Point, MD	45,000	N	clamshell	barged to an upland disposal site at Marley Patapsco Company	79-0349-3
8/29/79	Canton Elevator Division - CSY Finance, Baltimore	Patapsco River near Lazaretto Point, MD	20,000	N	clamshell	upland	79-0214-3
12/15/78	Baltimore City Mayor & City Council	Patapsco River at Baltimore City, MD	100	N	dragline	used as backfill	78-1051-1
6/26/79	Bethlehem Steel Corp.	Northwest Branch of the Patapsco River, MD	65	N	clamshell	landward of bulkhead	79-0149-3
4/13/79	Mekka Marina Construction & Diving Company, Inc. Alexandria, VA	Occoquan River at Woodbridge, VA	8,000	N	dragline	Rainwater Concrete Co. landward of MHW shoreline	78-6007
7/16/79	Welch, Harvey R.	Old Man Creek at Severna Park, VA	250	N	clamshell	landward of bulkhead	79-0060-2
4/18/79	Harford County Dept. of Parks & Recreation (Bel Air, MD)	Otter Point Creek at Flying Point, MD	2,500	M		upland	79-0016-1
9/20/79	Cecil County Dept. of Public Works	Northeast River at Charlestown, MD	2,000	N	mechanical	landward of MHW shoreline upland	79-0211
2/9/79	Shelter Cove Yacht Basin and Marinia Inc.	Northeast River at Hence's Point, MD	15,000	M		upland	78-1127
2/2/79	Hanson, Waldo	Nanticoke River near Cokeland, MD	592	M		spoil piles with breaks adjacent to ditch	78-1212
11/15/78	Delmarva Power and Light Company	Nanticoke River at Vienna, MD	700	M		upland disposal	78-1005
6/2/79	Magenan, Mary	Rockhold Creek near Drum Point, MD	330	M	clamshell		80-0202-3
9/28/79	Eastern Bay Development Company (D.C.)	Shipping Creek near Normans, MD	150	N	clamshell	landward of bulkhead	79-0114
6/6/79	Kowitch, Lawrence	Shipping Creek at Butler's Landing, MD	5	M		landward of bulkhead	78-1217
10/17/78	Bradley, L.B. (Baltimore)	Slaughter Creek near Taylors Island, MD	600	M	clamshell	landward of MHW shoreline	78-0982
5/3/79	Baughman, Wilbur, MD	Spa Creek, Annapolis, MD	650	N	clamshell	landward of bulkhead	78-1334-1
5/11/79	Overton, Lon	Spa Creek at Annapolis, MD	415	N	clamshell	at a landfill	79-0422-1
6/26/79	Dept. of Natural Resources, Maryland State, Annapolis	Tanner Creek near Scotland, MD	50,000	N	hydraulic	designated spoil sites landward of MHW shoreline	78-1240
11/27/78	A.H. Owens & Son	Susquehanna River, PA	4,200	N	clamshell	upland site	78-1120
7/13/79	Armstrong Cork Company	Susquehanna River at Marietta, PA	60	N	backhoe	redeposited in the trench	78-0853-3
7/18/79	Philadelphia Electric Company	Susquehanna River at Beach Bottom, PA	25,000	N	hydraulic	upland disposal area	78-0866-3
3/22/79	Holtz, Lester S.	Tar Cove Rock Creek at Pasadena, MD	250	N	dragline	landward of bulkhead	78-1091-1
4/17/79	Edwin A. & John O. Crandell, Inc.	Tenthouse Creek at Galesville, MD	4,500	N	clamshell or dragline	upland site	78-1236-1
4/18/79	Oyster, Tom	Thompson Creek near Stevensville, MD	400	M	clamshell or dragline	upland spoil site	78-1266
11/21/78	Queen Annes County Commissioners of, Courthouse, Centreville	Thompson Creek near Stevensville, MD	1,500	M	dragline		78-0999-5
1/10/79	Crockett Brothers Boatyard	Town Creek at Oxford, MD	130	N		upland	79-0075
7/30/79	Oyster, Thomas G.	Warehouse Creek near Stevensville, MD	870	M		upland & vegetated tital wetlands	79-0117
1/31/79	Dorchester County Highway Dept. Cambridge, MD	Warwick River at Secretary, MD	2,000	M		upland disposal site	78-1340

TABLE A-33 (concluded)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1979

Date	Permittee	Location	Total Amount Dredged	N M	Method Used for Dredging	Disposal Site	File Number
5/10/79	Anchor Properties	Wells Cove at Island Creek, MD	900	M	clamshell	upland site	78-1087-1
2/5/79	Salisbury, City of, County Government Building	Wicomico River at Salisbury, MD	700	N		upland disposal area	78-1134
11/22/78	Queen Anne County Commission, Dept. of Public Works	Winchester Creek at Grasonville, MD	3,400	M	hydraulic	spoil disposal area	78-0705
8/13/79	Queen Frnes Co.	Borsica River at Centerville	37,000		hydraulic	landward	79-0078
5/8/79	Bozman Randall	Mine Creek at French Town	100	M		landward of bulkhead	77-0965
7/18/79	Md. Dept. of Transportation	Northwest Branch of Patapsco River at Dundalk Marine Terminal	750,000		clamshell	landward channelward of MHW shoreline	80-0355-3
6/6/79	The Arundel Corp. (Baltimore)	Patapsco River near Brooklyn	101,000		clamshell	landward of berm	78-1193-1
8/23/79	Dorchester to Highway Dept. (Cambridge, MD)	White Hall Creek near Cambridge, MD	2,777		clamshell	upland	78-1375
6/5/79	Broome County	Chenango River					79-0578

TABLE A-34

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1980

Date	Permittee	Location	Total Amount Dredged	N M	Method Used for Dredging	Disposal Site	File Number
10/7/80	Baltimore Gas & Electric Building	Chesapeake Bay at Calvert Cliffs Nuclear Power Plant, MD	9,900	N	clamshell	upland and contained	80-0508
2/7/80	Carpenter, Lloyd	Chesapeake Bay at Taylors Island, MD	150	M	clamshell	upland site on applicant's property	79-0988
9/26/80	Jackson, Murray E.	Cherry Cove & Breton Bay, MD	1,200	N	dragline	landward to designated spoil area	80-0613
4/18/80	Dorchester County Highway Dept.	Cambridge Creek, MD	300	N	mechanical	upland	79-0309
5/21/80	Virginia Electric & Power Company	Cameron Run, VA	97	N	backhoe		79-6048
10/26/79	Tower Gardens Improvement	Carter Creek, MD	600	M	mechanical	upland spoil site	79-0339
3/21/80	Buck, Donald	Blackhole Creek, MD	40	N	clamshell	use as backfill landward of proposed bulkhead	79-1072-6
11/15/80	Robbins, David	Shorters Marsh adjacent to Blackwater River	2,715	N		adjacent to spoil banks	80-0144
11/16/80	Allen, John	Branson Cove, VA	1,200	N	dragline	behind earthen berm upland	79-6034
4/2/80	Mardela Springs	Barren Creek, MD	100	N		use as fill material	79-1137
8/27/80	Hacking, Edward G.	Assawoman Bay, MD	823	N		backfill landward of canal	80-0094
9/30/80	U.S. Army Fort Belvoir, VA	Accotink Creek, Fort Belvoir, VA	5,600	N	dragline	upland and confined behind earthen berm	80-6036
4/15/80	Potomac Electric Power Company	Anacostia River, MD	22,000/ 10 years	N	hydraulic	diked disposal area landward	79-1163
2/7/80	Wroten, Charles F.	Fishing Creek at Honga, MD	425	N	clamshell	landward of bulkhead	79-0337
11/23/79	City of Alexandria VA	Four Mile Run in Alexandria, VA	10,000	M	dragline		76-0028
1/3/80	Edwards Boatyard, Inc.	Frog Mortar Creek, MD	200	M	dragline	deposited & retained landward of bulkhead on applicant's property	78-1130-3
7/26/80	Gaffney, James J.	Fenwick Ditch at Ocean City, MD	250	N	mechanical	vacant adjacent upland lots	80-0095
11/26/79	Kettler, Milton	Eastern Bay & Longpoint, MD	30,600	N	hydraulic	diked disposal area on uplands owned by applicant	76-1112
8/27/80	J.W. Green Construction Corp.	Deep Creek, MD	280	N	clamshell	landward of proposed bulkhead	80-0434-4
1/23/80	W.R. Grace & Co.	Curtis Creek, MD	10,000	N	hydraulic	existing spoil pond on Sliold's Point	79-1050-2
4/8/80	Flinchum, A.J. Jr.	Cypress Creek, MD	111	N	clamshell	Joy Reclamation Company landfill	79-1195-4
1/3/80	Kirchner, Ralph A.	Crab Alley at Dominion, MD	20	M	clamshell	upland	79-0163
7/26/80	U.S.S. Realty Development Division	Cuckold Creek at Swan Point, MD	150	N	clamshell	landward of the mean high water shoreline	80-0162
8/14/80	Maryland Toll Facilities Administration	Curtis Creek near Baltimore, MD	30,000	N	clamshell	disposal site of Marley Neck	80-0293-1
10/16/79	Yereskovsky, Alexander	Corsica River, MD	445	N	dragline	on beach landward of the mean water shoreline	79-0591
2/22/80	Lindamoor Improvement Association	Cove of Cork at Lindamoor, MD	462	N	dragline	upland site	79-1155-1
7/20/80	Weintraub, William	Cove of Cork at Lindamoor, MD	900	M	clamshell	upland spoil site	79-0719-6
11/13/79	Queen Anne's County Dept. of Public Works	Cox Creek at Kent Narrows, MD	1,500	N	mechanical	trucked away to upland site	79-0036
8/1/80	Johnston, Randolph P.	Crab Alley Bay at Johnson Island, MD	350	N		landward	79-1064
7/13/80	Cordorus Creek Development	Cordorus Creek, PA	625	N		York County landfill	79-1041-2
1/28/80	Harlfinger, F.	Church Creek at Wooford, MD	100	N	mechanical	upland site	79-0984
4/1/80	Virginia Dept. of Highways and Transportation	Chopowamsic Creek, VA	500	N	dragline	use as fill	79-6087

TABLE A-34 (continued)
DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1980

Date	Permittee	Location	Total Amount Dredged	N M	Method Used for Dredging	Disposal Site	File Number
4/15/80	Maryland Dept. of Transportation	Choptank River, MD	7,100	N	clamshell or dragline	approved upland site	79-0685
1/28/80	Hall, Norris	Chester River near Kingstown, MD	300	N	mechanical	landward of riprap	78-0672
12/14/79	Loos, Dickson	Chincoeaque Bay at Tazzards Island, MD	1,000	M	dragline	deposited on wetland	79-0303
9/5/80	Scotts Cove Marina	Haines Creek & Scotts Cove, MD	15,240	M	dragline	landward of proposed bulkhead	79-007-4
8/15/80	Powley, Mary P.	Hearns Cove off Honga River, MD	780	N	clamshell	340 cu. yd. landward of bulkhead. rest on upland disposal site	80-0261
1/18/80	Powley, Mary P.	Hearns Cove off Honga River, MD	300	M	mechanical	landward of bulkhead	79-0144
5/27/80	Alexandria, City of	Hoof's Run, Alexandria, VA	1,800	M		upland	78-0960
10/22/79	Baltimore County Dept. of Public Transportation	Hopkins Creek, MD	1	N	dragline or backhoe	upland sit-	79-0813-1
6/19/80	Hohn, Henry H.	Hungerford Creek, MD	150	N	clamshell	beind bulkhead	80-0006
5/15/80	Woodman, De Greaf, Dr.	Island Creek near Oxford, MD	250	N	clamshell	upland site & retained by dike	80-0072
9/3/80	Queen Anne's County, Commissioners of	Kent Island Narrows near Grasonville, MD	7,155	M	mechanical	upland	78-1033
5/28/80	Severn Marina Services, Inc.	Knapps Narrows at Tighlman, MD	4,500	M	hydraulic or clamshell	retained upland	80-0134
5/21/80	Lake Hillsmere Group	Lake Hillsmere, MD	875	M	clamshell	upland site	79-0132-1
12/14/79	Dickerson Boatyard, Inc.	Lattrappe Creek, MD	6,800	N		upland site	79-0861
4/25/80	Meyer, Robert C.	Letha Pond, MD	45	N	clamshell	upland on applicant's property	80-0089-3
9/22/80	J.C.W. Tawes & Son	Little Annemessex, MD	20	N		landward of bulkhead	80-0080
4/25/80	Little Magothy River Association	Little Magothy River, MD	14,500	N	clamshell	on beach area	79-1083-2
9/18/80	Cabin Point, Inc.	Lower Machodoc Creek, MD	15,000	N	hydraulic	designated spoil area	75-1317
6/13/80	Reifsnyder, C. Frank	Magothy River at Gibson Island, MD	2,500	N	dragline	landward of bulkhead	79-0832-2
5/15/80	Anne Arundel County Dept of Public Works	Marley Creek at Point Pleasant, MD	3,545 113 3,659	N	clamshell	backfill, 113 cu. yd. upland	79-0814-1
11/13/79	Eastern Yacht Club, Inc.	Middle River at Essex, MD	4,500	N	clamshell	trucked to sanitary landfill	79-0109-2
4/30/80	Ruff, Harold	Miles River, MD	600	N	mechanical	upland	78-0673
4/3/80	Winter, Paul	Rioll Cove on Brooks Creek, MD	70	N	clamshell	upland on applicant's property	80-0034
2/7/80	Kendall, Calvin	Rock Hall Harbor at Rock Hall, MD	950	N	dragline	upland on applicant's property	79-0758
1/21/80	Sailing Emporium, Inc.	Rock Hall Harbor, at Rock Hall, MD	6,000	N	hydraulic	upland spoil disposal area	78-1354
6/27/80	Willard, Fred (Chestertown)	Rock Hall Harbor, at Rock Hall, MD	550	N	dragline	Sharptown Dump	79-1104
3/19/80	Prince William Forest Part (Triangle)	South Branch of Quantico Creek, VA	12,000	N	hydraulic	piped to disposal site effluent returned to lake	79-6079
10/12/79	Virginia Electric Power Company (Richmond)	Potomac River at Possum Point, VA	40,650	N	hydraulic	2 existing ash ponds on	79-6001
6/16/80	Colonial Pipeline Company (Richmond, Charles, E. Alford)	Potomac River upstream from Watkins Island, MD	10,966	N	backhoe, clamshell	10,163 cu. yd. as backfill rest landward of MHW Shoreline	79-6042
8/5/80	Moore, Dennis S.	Pooles Gut. Ramsey Lake, MD	111	N	hydraulic	upland	80-0302-1
10/22/79	Bower, Harry W. & Millis, James (Port Tobacco)	Port Tobacco River at Port Tobacco, MD	266	M	gradall	spoil area landward of MHW shoreline	79-0761

TABLE A-34 (concluded)

DREDGING STATISTICS FOR PRIVATE CONTRACTS IN THE CHESAPEAKE BAY: BALTIMORE DISTRICT; FISCAL YEAR 1980

Date	Permittee	Location	Total Amount Dredged	N M	Method Used for Dredging	Disposal Site	File Number
10/11/79	Norfolk, Baltimore and Caroline Line, Inc. (Baltimore)	Patapsco River in Baltimore Harbor, MD	4,000	N	bucket	barged to the diked disposal area at Hawkins Point	79-399-2
5/9/80	Rukert Terminals	Patapsco River in Baltimore City, MD	25,000	M	clambucket	Marley Neck Disposal Site	80-0203-1
1/17/80	Schaefer, John A.	Patapsco River, Northwest Harbor, Baltimore City, MD	510	N	dragline or clamshell	Marley Neck Disposal Site	79-1122-1
8/4/80	Maryland Dept. of Transportation	Northwest Branch of Patapsco at Dundalk, MD	135,000	N	clamshell	landward channelward of MHW shoreline	80-0355-3
8/22/80	Bethlehem Steel Co.	Patapsco River at Sparrows, MD	5,000	N		contained area	80-0536-1
12/5/79	Conoco, Inc. (Georgia)	Patapsco River at Fairfield, MD	15,200	N	dragline or hydraulic	Marley Neck Disposal Site	79-0931-1
9/12/80	Amstar Corp.	Patapsco River at Baltimore, MD	60,000	N	clamshell	Marley Creek	80-0549-1
2/14/80	Baltimore City Interstate Division	Patapsco River at Baltimore, MD	3,400,000	N		upland contained	79-0963
4/17/80	Skyline Terminals	Patapsco River at Fairfield, MD	100,000	N	clamshell	Marley Neck Disposal Site	79-1169-1
5/7/80	Oyster Harbor Citizen's Association	Oyster Creek & Chesapeake Bay near Annapolis, MD	1,100	N	dragline	landward of bulkhead on beach area	80-0120-2
1/10/80	Wicks, Richard F.	Sassafras River at Fredericktown, MD	300	M	mechanical or hydraulic	upland spoil area	79-0038
9/17/80	Cropper, George B.	Sinepuxent Bay at Ocean City, MD	2,000	M	mechanical	upland site	79-1153
4/28/80	Elliot's Sports Marina	Sinepuxent Bay at West Ocean City, MD	7,500	M	hydraulic	upland on adjacent land	79-0759
6/18/80	Shifting Sand Realty (Ocean City)	Sinepuxent Bay at Ocean City, MD	500	M	mechanical	upland site	80-0294
5/21/80	Annapolis, City of	Spa Creek, Annapolis, MD	963 oyster shells 6,667 total	N	clamshell	63 cu. yd. used as backfill Annapolis landfill	80-0075-1
11/15/79	Bridges, Jack, H.	Spa Creek at Annapolis MD	25	N	clamshell	landward of bulkhead	79-0932-1
9/23/80	Pier 4 Marina Annapolis	Spa Creek at Annapolis, MD	50	N	clamshell	City of Annapolis landfill	80-0509-4
10/30/79	Port Deposit Marina	Susquehanna River at Port Deposit, MD	200	N	clamshell	upland in Port Deposit	79-0142
2/12/80	Tidewater Marina (Havre de Grace)	Susquehanna River at Havre de Grace, MD	1,200	N	clamshell	upland on applicant's property	79-1005-2
1/10/80	Wiley Manufacturing Company, Ed Johnston	Susquehanna River at Port Deposit, MD	4,000	N	clamshell	upland in a quarry	709-0585
7/10/80	Pennsylvania Fish Commission	North Branch of Susquehanna River near Danville, Montour City, PA	100	N	backhoe	used as construction fill	80-0339
3/21/80	Pennsylvania Power & Light Company	Susquehanna River at Byers Island, PA	800	N	clamshell bucket		79-1055-3
2/28/80	Sue Haven Yacht Club	Sue Creek at Turkey Point, MD	400	N		upland owned by applicant	79-1165-6
11/13/79	Higgins, John D.	St. Michaels Harbor at St. Michaels, MD		N	mechanical	upland site	79-0698
5/21/80	Budd, William C.	Warwick River at Secretary, MD	200	N	mechanical	upland site	79-0962
9/29/80	Glebe Harbor Property Owners Association	Weatherall Creek, VA	500	N	dragline	used for beach replenishment	80-6014
10/16/79	Stribling, John	Cypress Creek	175	N	clamshell	landward of bulkhead	78-0984-2
4/4/80	Dorchester Co. MD	Indian Creek near Cambridge	14,100	M	hydraulic	upland spoil area	79-0376
8/17/80	Fruey Robert	Upland Creek near Piney Point	37		backhoe or crane	inland spoil site	80-0172
6/6/80	Culver Ronald H.	Patuxent River	400		clamshell	upland site	79-1002
4/15/80	Borinthian Yacht Club	Putland Creek	220	M	backhoe and clamshell	disposal area landward of MHW shoreline	79-0933
9/26/80	Parr, Bertram	Muddy Creek near Grasonville	800			upland site	79-0597
3/18/80	Blackwell Clarence	Spa Creek at Annapolis	15		clamshell	Annapolis city landfill	79-1131-2
9/24/80	Bromwell Charles E. III	Woolford Creek near Madison	650		dragline	used in filling the existing ditch; rest upland on applicant's property	80-0177

APPENDIX B

EQUIPMENT OWNED BY MAJOR DREDGING COMPANIES WORKING IN THE CHESAPEAKE BAY

TABLE B-1

MAJOR COMPANIES PERFORMING FEDERAL DREDGING WORK IN THE CHESAPEAKE BAY AND AVAILABLE EQUIPMENT

NAME OF COMPANY AND ADDRESS	TYPE OF DREDGING EQUIPMENT	DREDGE'S NAME	DISCHARGE PIPE SIZE (in)	BUCKET CAPACITY Cu. Yd.	POWER hp	HOPPER CAPACITY Cu. Yd.
Norfolk Dredging Company	Clamshell	"Philos"		3	250	
P.O. Box 539	Clamshell	"428"		10	1100	
Norfolk, VA 23501	Clamshell	"111"		6	800	
	Cutter suction	"Pullen"	22			
	Cutter suction	"Essex"	18			
	Cutter suction	"Talcott"	18			
	Cutter suction	"Ft. Pierce"	16			
	Cutter suction	"Jekyll Island"	14			
	Cutter suction	"Manteo"	12			
Cottrell Engineering Company	Cutter suction	"Richmond"	12		1000	
541 Front Street	Cutter suction	"Marion"	12		1000	
Norfolk, VA 23510	Cutter suction	"Neuse"	12		800	
	Cutter suction	"Blue Ridge"	12		500	
Atkinson Dredging Company	Cutter suction	"Enterprise"	18			
P.O. Box 15284	Cutter suction	"Hampton Roads"	18			
Chesapeake, VA 23320	Cutter suction	"Northwood"	16			
American Dredging Company	Cutter suction	"ADCO"	27			
P.O. Box 190 Delaware Ave.	Cutter suction	"American"	27			
and State Street	Cutter suction	"Arkansas	27			
Camden., N.J. 08101	Cutter suction	"Ozark"	27			
	Cutter suction	"Maryland"	16			
	Cutter suction	"Erie"	16			
	Cutter suction	"Chester"	16			
	Cutter suction	"New Jersey II"	14			
	Cutter suction	"Chesapeake II"	12			
	Booster station	"Booster No. 1"	27			
	Booster station	Booster No. 2"	16			
	Floating grab/clamshell	"Ranger"				
	Floating grab/clamshell	"Titan"				
	Floating grab/clamshell	"New York"				
	Floating grab/clamshell	"Convoy"				

TABLE B-1 (Continued)

MAJOR COMPANIES PERFORMING FEDERAL DREDGING WORK IN THE CHESAPEAKE BAY AND AVAILABLE EQUIPMENT

NAME OF COMPANY AND ADDRESS	TYPE OF DREDGING EQUIPMENT	DREDGE'S NAME	DISCHARGE PIPE SIZE (in)	BUCKET CAPACITY Cu. Yd.	POWER hp	HOPPER CAPACITY Cu. Yd.
American Dredging Company (Cont.)	Bucket dipper	"Delaware Valley"				
P.O. Box 190 Delaware Ave.	Bucket dipper	"President"				
and State Street						
Camden, N.J. 08101						
Barnegat Bay Dredging Company	Cutter suction	"Mike Thomas"	12		1300	
Inc.	Booster station	"Reynold Thomas"	12		700	
Box 336, 8101 Bay Terrace,						
Harvey Cedars, N.J. 08040						
Spickard Enterprises, Inc.	Cutter suction	"Raritan"	12			
390 Beaumont Avenue						
Tuckerton, N.J.						
Great Lakes International Inc.	Cutter suction	"Illinois"	27			
2122 York Rd.	Cutter suction	"Alaska"	27			
Oak Brook, Il. 60502	Cutter suction	"New York"	27			
	Cutter suction	"Georgia"	26			
	Cutter suction	"Louisiana"	25			
	Cutter suction	"Puerto Rico"	24			
	Cutter suction	"Rhode Island"	14			
	Bucket dipper	"Crest"	12			
	Bucket dipper	"Boston"	10			
	Bucket dipper	"Cleveland"	10			
	Bucket dipper	"Mogul"	10			
	Clamshell	"No. 51"	9-15			
	Clamshell	"No. 52"	10-22			
	Clamshell	"No. 54"	10-22			
	Clamshell	--------	9-18			
	Clamshell	--------	9-18			
	Clamshell	"Conical"	6-12			
	Clamshell	"No. 50"	6-14			
	Clamshell	"No. 55"	5-12			
	Clamshell	"No. 56"	5-12			
	Clamshell	"No. 811"	4-6			

TABLE B-1 (Concluded)

MAJOR COMPANIES PERFORMING FEDERAL DREDGING WORK IN THE CHESAPEAKE BAY AND AVAILABLE EQUIPMENT

NAME OF COMPANY AND ADDRESS	TYPE OF DREDGING EQUIPMENT	DREDGE'S NAME	DISCHARGE PIPE SIZE (in)	BUCKET CAPACITY Cu. Yd.	POWER hp	HOPPER CAPACITY Cu. Yd.
Great Lakes International Inc.(Cont.) 2122 York Rd. Oak Brook, IL 60521	Trailing suction Hopper Dredge	"Long Island"				16,000
	Hopper Dredge	"Padre Island"	24		6550	3,600
	Hopper Dredge	"Manhattan Island"	24		6750	3,600
	Hopper Dredge	"Sugar Island"	24		9470	3,600
	Hopper Dredge	"Dodge Island"	24		9470	1,300

APPENDIX C

BIBLIOGRAPHY

Alden, R. W., III, Undated. Ocean Disposal: An Ecological Assessment of Spoils from the Port of Hampton Roads, Virginia. Presented at Dredging Technology Seminar, 26-27 August 1981. Co-Sponsored by the School of Engineering, Old Dominion University and the Norfolk District of the U.S. Army Corps of Engineers. Department of Biological Sciences, Old Dominion University, Norfolk, Virginia.

American Marine and Machinery Co., Inc., 1980. Manufacturer's Brochure. Nashville, Tennessee.

AMTEC Development Corporation, 1981. Equipment Brochure. Highland Park, Illinois.

Anonymous, 1978. Lasers: New Dimension in Port Construction. American Seaport, June, pp. 31-32.

Anonymous, 1980a. Directory of the World's Dredges and Suppliers. World Dredging and Marine Construction 16(2):33-111.

Anoymous, 1980b. Bibliography of Dredging Technology. World Dredging and Marine Construction 16(10):31-63.

Anonymous, 1981. Electronics in Dredging. World Dredging and Marine Construction 17(3):9-13.

Bates, A. D., 1979. Buckets Full of Promise. Consulting Engineer, October, pp. 57-69.

Bean Dredging Corporation, 1980. Company Brochure and Equipment Listing. New Orleans, Louisiana.

Biller, R. A., 1980. Personal Communication. Chief of International Staff, U.S. Coast Guard, Washington, D.C.

Blankinship, B. T., 1975. Problems and Challenges in the Dredging Program of the U.S. Army Corps of Engineers. Proceedings of World Dredging Conference No. VI, pp. 17-35. WODCON Association, San Pedro, California.

Bray, R. N., 1977. Choosing the Right Dredger for the Job. International Dredging and Marine Construction 13(7):20-24.

Bray, R. N., 1979. Dredging, a Handbook for Engineers. Edward Arnold, New York, New York.

Bray, R. N., 1980. Dredging and the Environment. Civil Engineering 50(2):22-25.

Brown, K., and Thompson, L. J., 1977. Dewatering of Confined Dredge Spoil Areas. Paper G1. Second International Symposium on Dredging Technology. BHRA Fluid Engineering, Cranfield, Bedford, England.

Bunce, E. B., 1965. Two Stage Dredging Method Allows Continuous Operation. Construction Methods and Equipment, March 1965, pp. 84-89.

Bure, H. P., 1978. Rebirth of the Dredging Industry. World Dredging and Marine Construction 14(7):36-39.

Cable, C. C., 1969. Optimum Dredging and Disposal Practices in Estuaries. Journal of the Hydraulic Division. Proceedings of American Society of Civil Engineers 95(HY1):103-114.

Carpenter, J. H., 1977. Limiting Factors that Control Dredging Activities in the Estuarine Zone, pp. 217-223. In: Office of Water Planning and Standards, U.S. Environmental Protection Agency. Estuarine Pollution Control and Assessment, vol. 1. U.S. Government Printing Office, Washington, D.C.

Conner, J. R., 1976. Chemical Fixation and Solidification of Dredge Spoils, pp. 235-257. Proceedings of World Dredging Conference No. VII. WODCON Association, San Pedro, California.

Conner, W., Aurand, D., Leslie, M., Slaughter, J., Amr, A., and Ravenscroft, F. I., 1979. Disposal of Dredged Material within the New York District, vol. 1. Current Practices and Candidate Alternatives. MTR 7808-01. The MITRE Corporation, McLean, Virginia.

Cooper, H. R., 1975. Practical Dredging and Allied Subjects. Brown, Son & Ferguson, Ltd., Glasgow, England.

Cronin, E. L. (ed.), 1970. Gross Physical and Biological Effects of Overboard Spoil Disposal in Upper Chesapeake Bay. Natural Resource Institute Special Report No. 3. Chesapeake Biological Laboratory, Solomons, Maryland.

Cronin, W. B., Gross, M. G., Whaley, R. C., Boicourt, W., Schubel, J. R., and Taylor, W. R., 1978. Investigations of Dredging Operations, Craighill Angle-Patapsco River Mouth Disposal Site. Final Report to Department of Natural Resources, State of Maryland and the Baltimore District, U.S. Army Corps of Engineers. Open File Report No. 12. Annapolis, Maryland.

D' Angremond, K., Brakel, J., Hoekstra, A. J., Kleinbloesem, W. C. H. Nederof, L., and de Nekker, J., 1978. Assessment of Certain European Dredging Practices and Dredged Material Containment and Reclamation Methods. Technical Report D-78-58. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

D' Heur, A. P., 1981. Personal Communication. U.S. Customs Service, Office of Inspection, Washington, D.C.

Delta Dredge and Pump Corporation, 1980. Manufacturer's Brochure. St. Louis, Missouri.

Diaz, R. J., and Boesch, D. F., 1977. Impact of Fluid Mud Dredged Material on Benthic Communities of the Tidal James River, Virginia. Technical Report D-77-45. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

Dixhoorn, J. van, 1972. Modern Dredging Techniques. Terra et Aqua, Nov. 1972.

Dredge Masters International, Inc., Undated. Manufacturer's Brochure and Technical Specifications. Hendersonville, Tennessee.

Dolber, F., 1981. 15th Annual Directory of Dredgers and Suppliers. World Dredging and Marine Construction 17(2):61-71.

Dunn, J. T., 1975. Space Age Electronics Boost Dredging Efficiency. World Dredging and Marine Construction 11(8):18-21.

Durkay, J., 1981. Personal Communication. U.S. Army Corps of Engineers, Baltimore District, Baltimore, Maryland.

Ellicott Machine Corporation, Undated. Company Brochure and Technical Specifications. Baltimore, Maryland.

Farragut, P., 1981. Baltimore Dredging Depends on Suitable Disposal Sites. World Dredging and Marine Construction 17(1):20.

Filip, T., 1981. Personal Communications. U.S. Army Corps of Engineers, Baltimore District, Baltimore, Maryland.

Freed, R. J., and Abell, P. A., 1979. Sediment Analyses of the Craighill Angle and the Patapsco River Disposal Area. Enviroplan Inc., Baltimore, Maryland.

Freed, R. J., and Abell, P. A., 1980. Sediment Sampling and Analysis, Craighill Angle, Cutoff Angle, Patapsco River Disposal Area, and Pooles Island Deep Disposal Area. Enviroplan Inc., Baltimore, Maryland.

Great Lakes Dredge and Dock Co., Undated. Company Brochure and Annual Report, 1980. Oak Brook, Florida.

Greenwood, D. R., Kingsbury, G. L., and Cleland, J. G., 1979. A Handbook of Key Federal Regulations and Criteria for Multimedia Environmental Control. EPA 68-02-2612. Environmental Protection Agency, Washington, D.C.

Gross, M. G., and Cronin, W. B., 1979. Dredging and Disposal in Chesapeake Bay, 1975-2025, pp. 131-145. In: Palmer, H. D., Gross, M. G. (eds.). Ocean Dumping and Marine Pollution. Dowden, Hutchinson & Ross, Inc., Stroudsburg, Pennsylvania.

Gross, M. G., Karweit, M., Cronin, W. B., and Schubel, J. R., 1978. Suspended Sediment Discharge of the Susquehanna River to Northern Chesapeake Bay, 1966-1976. Estuaries 1(2):106-110.

Hachiro, F., 1975. An Overview of Dredging in Japan, pp. 11-16. Proceedings of World Dredging Conference No. VI. WODCON Association, San Pedro, California.

Haliburton, A. T., 1979. Best Ways to Dewater Dredged Material. Civil Engineering 49(8):57-61.

Haller, D., 1981. Personal Communication. U.S. Army Corps of Engineers, Norfolk District, Norfolk, Virginia.

Hammond, R., 1969. Modern Dredging Practice. Frederick Muller, London, England.

Hansen, R. S., 1971. Great Lakes Dredging: Problems and Remedies. World Dredging and Marine Construction 7:16-20.

Harris, D., 1981. Personal Communication. AMTEC Development Company, Highland Park, Illinois.

Herbich, J. B., 1974. Coastal and Deep Ocean Dredging. Gulf Publishing Company, Houston, Texas.

Hirsch, N. D., DiSalvo, L. H., and Peddicord, R., 1978. Effects of Dredging and Disposal on Aquatic Organisms. Technical Report DS-78-5. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

Hoffman, J. F., 1978a. European Dredging, Review of the State of the Art. London Report R-12-78. Office of Naval Research, Washington, D.C.

Hoffman, J. F., 1978b. New Methods for Dredging Pier Slips. Coastal Zone 1978. Symposium on Technical, Environmental, Socioeconomic and Regulatory Aspects of Coastal Zone Management. American Society of Civil Engineers, New York, New York.

Holland, R., 1981. Personal Communication. Great Lakes Dredge and Dock Company, Towson, Maryland.

Hubbard, B. S., and Herbich, J. B., 1977. Productive Land Use of Dredged Material. Paper F1. Second International Symposium on Dredging Technology. BHRA Fluid Engineering, Cranfield, Bedford, England.

Hull, W., 1981. Personal Communication. Atkinson Dredging Company, Chesapeake, Virginia.

Huston, J., 1976. Techniques for Reducing Turbidity with Present Dredging Procedures and Operations, pp. 163-181. Proceedings of the World Dredging Conference No. VII. WODCON Association, San Pedro, California.

JBF Scientific Corporation, 1978. An Analysis of the Functional Capabilities and Performance of Silt Curtains. Technical Report D-78-39. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

Jensen, R., 1979. Oozer Pump Dredge Manufacturer's Brochure. TJK, Inc., N. Hollywood, California.

Jenson, R., 1981 Personal Communication. TJK, Inc., N. Hollywood, Florida.

Johanson, E. E., 1976. The Effectiveness of Silt Curtains (Barriers) in Controlling Turbidity, pp. 183-206. Proceedings of the World Dredging Conference No. VII. WODCON Association, San Pedro, California.

Kennedy, V. S., Krantz, G. E., 1978. Biological, Chemical and Physical Effects of Dredging and Overboard Spoil Disposal at the Mouth of the Patapsco River, with an Evaluation of Benthic Recolonization of Dredge Spoil and Recovery of Disturbed Benthic Community. Center for Environmental and Estuarine Studies, University of Maryland, Cambridge, Maryland.

Krenkel, P. A., Harrisson, J., and Burdick, J. C., III (eds.), 1976. Dredging and its Environmental Effects: Proceedings of the Specialty Conference. The American Society of Civil Engineers, New York, New York.

Larsen, N., 1980. Industry in the Bay--Environmental Disputes. Chesapeake Bay and Industry Seminar, October 9, 1980. Citzens Program for the Chesapeake Bay, Inc., Hampton, Virginia.

Lee, G. F., 1977. Significance of Chemical Contaminants in Dredged Sediment on Estuarine Water Quality, pp. 211-216. In: Office of Water Planning and Standards, U.S. Environmental Protection Agency. Estuarine Pollution Control and Assessment, vol. 1. U.S. Government Printing Office, Washington, D.C.

Leslie, M., Aurand, D., Schultz, D. and Holman, R., 1980. Disposal of Dredged Material within the New York District, vol. 2. Preliminary Evaluation of Upland Disposal. MTR 7808-02. The MITRE Corporation, McLean, Virginia.

Maloblocki, R., 1981. Personal Communications. AMTEC Development Company, Highland Park, Florida.

Maryland Department of Natural Resources, 1981. Dredging and Spoil Disposal. Maryland Coastal Report Number 4. Coastal Resources Division, Tidewater Administration, Baltimore, Maryland.

McDonald, B., 1980. Dredge Now or Die Later. Marine Engineering/Log, June, pp. 34-37.

McKee, J., 1981/1982. Personal Communications. Navigation Branch, U.S. Army Corps of Engineers, Baltimore District, Baltimore, Maryland.

McLean Contracting Company, Undated. Company Brochure. Baltimore, Maryland.

Mullins, T., 1977. The Chemistry of Water Pollution, pp. 331-400. In: Brockes, J. O. (ed). Environmental Chemistry. Plenum Press, New York, New York.

Murden, W. R., Jr., 1978. The Development of New Dredging Procedures. Defense Technical Information Center, Defense Logistics Agency, Alexandria, Virginia.

Murden, W. R., Jr., 1980. Dredging on a Competitive Basis. Management of Bottom Sediments Containing Toxic Substances. Proceedings of the 5th U.S.-Japan Experts Meeting. Environmental Research Laboratory, U.S. Environmental Protection Agency, Corvallis, Oregon.

Murden, W. R., Jr., 1981. Personal Communications. Institute for Water Resources, U. S. Army Corps of Engineers, Ft. Belvoir, Virginia.

National Car Rental System, Inc., Undated. MUD CAT Dredge Manufacturer's Brochures. MUD CAT Division, St. Louis Park, Minnesota.

Neff, J. W., Foster, R. S., and Slowey, J. F., 1978. Availability of Sediment Absorbed Heavy Metals to Benthos with Particular Emphasis on Deposit-Feeding Infauna. Technical Report D-78-42. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

Nichols, M., 1972. Sediments of the James River Estuary, Virginia, pp. 169-213. In: Nelson, B. W. (ed). Environmental Framework of Coastal Plain Estuaries. Geol. Soc. Amer. Memoir 133.

Nishi, K., 1976. Dredging of High-Density Sludge Using Oozer Pump, pp. 751-778. Proceedings of the World Dredging Conference No. VII. WODCON Association, San Pedro, California.

Nordstrom, K. F., Hastings, R. W., and Bonsall, S., 1974. An Environmental Impact Assessment of Maintenance Dredging of the New Jersey Intercoastal Waterway. Technical Report No. 74-1. Marine Sciences Center, Rutgers--The State University of New Jersey, New Brunswick, New Jersey.

Nordstrom, K. F., and Kucma, G. A., 1978. The Suitability of Dredge Spoil as Beach Fill at Berkeley Township, New Jersey. Proceedings, Middle States Division, Association of American Geographers. Rutgers--The State University of New Jersey, New Brunswick, New Jersey.

Nordstrom, K. F., 1974. The Use of Dredged Spoil as Beach Fill on the New Jersey Beaches. Proceedings, Middle States Division, Association of American Geographers, 1974. Rutgers--the State University of New Jersey, Department of Geography, New Brunswick, New Jersey.

Norfolk Dredging Co., Undated. Company Brochure. Norfolk, Viginia.

O'Brien, D. J., 1981. Sharing the Port Barrel. The New York Times, 16 April 1981, vol. 130, p. N-27.

Office of Technology Assessment, 1981. Coal Exports and Port Development. OTA-TM-O-8. Office of Technology Assessment, U.S. Congress. Superintendent of Documents, Washington, D.C.

Palmer, H. D., Schubel, J. R., and Cronin, W. B., 1975. Estuarine Sedimentology, Upper Bay Survey, vol. 2, Technical Report. Westinghouse Electric Corp., Oceanic Division, Annapolis, Maryland.

Peddicord, R. K., McFarland, V. A., Belfiori, D. P., and Byrd, T. E., 1975. Effects of Suspended Solids on San Franciso Bay Organisms. Dredge Disposal Study, San Francisco Bay and Estuary. U.S. Army Corps of Engineers, San Francisco District, San Francisco, California.

Peddicord, R. K., and McFarland, V. A., 1978. Effects of Suspended Dredged Material on Aquatic Animals. Technical Report D-78-29. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

Phillips, T., 1980-1981. Personal Communications. Geography Department, Rutgers--The State University of New Jersey, New Brunswick, New Jersey.

Pitts, J. T., 1981. Personal Communication. Director, Delmarva Water Transport Committee, Salisbury, Maryland.

Powers, J., 1980. Bucket Dredging Methods and Equipment. World Dredging and Marine Construction 16(12):11-14.

Sato, E., 1976. Application of Dredging Techniques for Environmental Problems, pp. 143-162. Proceedings of the World Dredging Conference No. VII. WODCON Association, San Pedro, California.

Saucier, R. T., Calhoun, C. C., Jr., Engler, R. M., Palin, T. R., and Smith, H. K., 1978. Executive Overview and Detailed Summary. Technical Report DS-78-22. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

Scholle, A. J., 1981. Personal Communication. Chief of Carrier Ruling Branch, U.S. Customs Service, Washington, D.C.

Schubel, J. R., 1968. Suspended Sediment of the Northern Chesapeake Bay. Technical Report 35. Johns Hopkins University, Baltimore, Maryland.

Schubel, J. R. (ed.), 1971. The Estuarine Environment and Estuarine Sedimentation. Short Course Lecture Notes. Amer. Geol. Inst., Washington, D.C.

Schubel, J. R., 1972. Distribution and Transportation of Suspended Sediment in Upper Chesapeake Bay, pp. 151-167. In: Nelson, B. W. (ed.). Environmental Framework of Coastal Plain Estuaries. Geol. Soc. Amer. Memoir 133.

Schubel, J. R., 1974. Effects of Tropical Storm Agnes on the Suspended Solids of the Northern Chesapeake Bay, pp. 113-132. In: Gibbs, R. J. (ed.). Suspended Solids in Water. Plenum Press, New York, New York.

Schubel, J. R., and Meade, R. H., 1977. Man's Impact on Estuarine Sedimentation, pp. 193-209. In: Office of Water Planning and Standards, U.S. Environmental Protection Agency. Estuarine Pollution Control and Assessment, vol. 1. U.S. Government Printing Office, Washington, D.C.

Schubel, J. R., Hirschberg, D. J., Pritchard, D. W., and Gross, M. G., 1980. A General Assessment of Selected Dredging/Disposal Operations for Three Federal Dredging Projects in Upper Chesapeake Bay. Special Report 40. Marine Science Research Center, State University of New York, Stony Brook, New York.

Schwarz, W. H., 1980. Personal Communication. McLean Contracting Company, Baltimore, Maryland.

Shenman, L., 1981. Personal Communication. District Sales Manager, MUD CAT, National Car Rental System, Inc., Fort Lee, New Jersey.

Smith, D. D., and Graham, K. F., 1976. The Effect of Institutional Constraints on Dredging Projects, San Diego Bay: A Case History, pp. 119-141. Proceedings of the World Dredging Conference No. VII. WODCON Association, San Pedro, California.

Sorensen, A. H., 1971. Equipment State-of-the-Art, U.S. Dredging Industry. World Dredging and Marine Construction 7(4):20-26.

Stefanides, E.J., 1980. Hydraulic Dredge Optimizes Solid Waste Mining. Design News, 5 May, pp. 86-87.

Stern, E. M., and Stickle, W. B., 1978. Effects of Turbidity and Suspended Material in Aquatic Environments: Literature Review. Technical Report D-78-21. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

Stribling, J. W., 1981. Personal Communication. Sales Manager, Ellicott Machine Corporation, Baltimore, Maryland.

Thorne, R. J., 1981. Personal Communication. Executive Vice President, Norfolk Dredging Company, Norfolk, Virginia.

Tofflemire, T. J., 1979. Improving the Efficiency of Dredging Several Feet of Contaminated Sediment off the Top of an Uncontaminated Sediment. Technical Paper No. 61. New York State Department of Environmental Conservation, Bureau of Water Research, Albany, New York.

Toxey, C., 1981. Personal Communication. U. S. Army Corps of Engineers, Norfolk District, Norfolk, Virginia.

Tsai, C-F., Welch, J., Chang, K-Y, Schaeffer, J., and Cronin, L. E., 1979. Bioassay of Baltimore Harbor Sediments. Estuaries 2: 141-153.

U.S. Army Corps of Engineers, 1969-79. Annual Reports. Baltimore District, Baltimore, Maryland.

U.S. Army Corps of Engineers, 1974. Operation and Maintenance of Baltimore Harbor and Associated Channels, Maryland and Virginia. Environmental Statement. Baltimore District, Baltimore, Maryland.

U.S. Army Corps of Engineers, 1976. Final Environmental Statement. Permit Application for Diked Disposal, Island Hart and Miller Islands, Baltimore County, Maryland. Baltimore District, Baltimore, Maryland.

U.S. Army Corps of Engineers, 1979a. Mississippi Sound and Adjacent Areas Reconnaissance Report. Appendix D, Dredging Equipment and Dredged Material Transportation and Disposal, Mobile. Mobile District, Mobile, Alabama.

U.S. Army Corps of Engineers, 1979b. Baltimore District Project Maps. Baltimore District, Baltimore, Maryland.

U.S. Army Corps of Engineers, 1981. Dredged Material Research, Notes, News, Reviews, etc., vol. D-81-2 (August 1981). Waterways Experiment Station, Vicksburg, Mississippi.

U.S. Environmental Protection Agency, 1974. Demonstration of the Separation and Disposal of Concentrated Sediments. EPA 660/2-74-072. Washington, D.C.

U.S. Environmental Protection Agency, 1976. Removal and Separation of Spilled Hazardous Materials from Impoundment Bottoms. EPA-600/2-76-245. Washington, D.C.

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers, 1977. Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Waters. Implementation Manual for Section 103 of Public Law 92-532. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers, 1978. The EPA Kepone Mitigation Feasibility Project Report. Remedial Conventional Measures for Capturing, Stabilizing or Removing Kepone in Bayley Bay, Bailey Creek, Gravelly Run, and the James River, Virginia, Appendix B. U.S. Army Corps of Engineers, Norfolk District, Norfolk, Virginia.

U.S. Department of the Interior, Fish and Wildlife Service, 1970. National Estuary Study, vol. 3, Appendix B, Management Studies in Specific Estuaries. Superintendent of Documents, Washington, D.C.

U.S. Department of Transportation, Federal Highway Administration and Maryland Department of Transportation State Highway Administration Interstate Division for Baltimore City, 1979. Fort McHenry Tunnel, vols. 1, 2, and 3. Technical Report 1. Maryland Department of Transportation, Baltimore, Maryland

Villa, O., Jr., and Johnson, P. G., 1974. Distribution of Metals in Baltimore Harbor Sediments. Environmental Protection Agency Technical Report 59. NTIS Report PB-229 258. National Technical Information Service, Springfield, Virginia.

Wade, T. L., and Wong, G. T. F., 1980. Temperature, Salinity, and Dissolved Oxygen Monitoring Program for Dredging Operations at the Norfolk Naval Shipyard (Portsmouth, VA). Department of Oceanography, School of Sciences and Health Professions, Old Dominion University, Norfolk, Virginia.

Wakeman, T. H., Dickson, W. J., and Sustar, J. F., 1975. Alternative Dredging Methods, Relative Physical Impact, pp. 429-453. Proceedings of the World Dredging Conference No. VI. WODCON Association, San Pedro, California.

Water Resource Administration, Maryland Department of Natural Resources, 1977. Management Alternatives for Dredging and Disposal Activities in Maryland Waters. Baltimore, Maryland.

Waterless Dredging Company, Undated. Model 8-180 Specifications. Mattoon, Illinois.

Whitehurst, G., 1981. Personal Communication. U.S. Army Corps of Engineers, Norfolk District, Norfolk, Virginia.

Williams, B. F., 1981. Personal Communication. U.S. Army Corps of Engineers, Norfolk, Virginia.

Wojciechowski, S., 1981. Personal Communication. U.S. Army Corps of Engineers, Philadelphia District, Philadelphia, Pennsylvania.

Wooton, F. T., 1980. Dredging and Disposal of Toxic Material Using Japanese Technology Suggested for United States. World Dredging and Marine Construction 16:14-15.